EtherMeter™

SCADA / METER GATEWAY

PATENT PENDING

MADE IN USA

AWWA C707-05 COMPLIANT

Installation, Operation, and Maintenance Manual

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AUTHORIZED SCADAMETRICS RESELLER

SCADAmetrics

St. Louis, Missouri USA

scadametrics.com

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1 INTRODUCTION

For many years, SCADA (Supervisory Control And Data Acquisition) system integrators have wrestled with the totalization errors that are inherent when using low-tech, pulse-output water meter registers.

With pulse-accumulation, the most commonly reported problem had always been the inevitable discrepancies between the meter readings displayed on the SCADA computers and the readings available on the physical meters themselves.

Today, SCADAmetrics has eradicated these errors with the introduction of the EtherMeter™ – the telemetry appliance that can finally ensure absolute agreement between the SCADA system and its connected meters… *revenue-grade* accuracy.

The effectiveness of the EtherMeter is based upon abandonment of pulse-counting techniques in favor of an embrace of the latest "absolute encoder" meter-reading technologies.

Driven by the powerful SCADAmeter™ protocol conversion engine, it works by translating totalization and flow rate signals from the newer, advanced AMR registers into industrial protocols that SCADA systems can understand, such as MODBUS®, Allen Bradley DF1, and EtherNet/IP™.

Additionally, because its flow calculation is based upon an internal delta-Volume/delta-Time algorithm, the EtherMeter can even detect and alarm reverse flows!

The purpose of this manual is to provide the system integrator with the know-how to set up, install, and maintain the EtherMeter – the new vital component built for today's modern SCADA systems.

An Installed EtherMeter™ AMR-Industrial Interface

2 RECOMMENDED SKILLS AND TOOLS

A. SKILLS FOR INSTALLING AND TROUBLESHOOTING AN ETHERMETER:

IT IS RECOMMENDED THAT THE OWNER OR SYSTEM INTEGRATOR READ THIS MANUAL THOROUGHLY BEFORE ATTEMPTING INSTALLATION, SETUP, OR TROUBLESHOOTING.

THE ETHERMETER IS DESIGNED TO BE SET UP AND INSTALLED BY A PROFESSIONAL ELECTRICIAN OR TECHNICIAN WITH EXPERTISE IN THE FIELD OF SCADA, TELEMETRY, INDUSTRIAL AUTOMATION, AND/OR INSTRUMENTATION.

IF THE SETUP TECHNICIAN LACKS THE REQUIRED EXPERTISE, THEN IT IS RECOMMENDED THAT A LOCAL INDUSTRIAL TECHNICIAN BE HIRED FOR THIS PURPOSE. AT A MINIMUM, THE PROFESSIONAL SHOULD BE FAMILIAR WITH THE FOLLOWING CONCEPTS:

1. BASIC WIRING TECHNIQUES
2. GROUNDING
3. AC/DC POWER SUPPLIES
4. SURGE SUPPRESSION AND ISOLATION TECHNIQUES
5. BASIC WATER METER TOTALIZATION AND FLOW CONCEPTS
6. USER EXPERIENCE WITH TERMINAL EMULATION SOFTWARE (EG HYPERTERMINAL)
7. USER EXPERIENCE WITH TELNET SOFTWARE
8. USER EXPERIENCE WITH WEB-BROWSER SOFTWARE
9. USING AND TROUBLESHOOTING INDUSTRIAL COMM PROTOCOLS (MODBUS, DF1, ETC.)
10. RS-232 SERIAL PORTS, CABLING, AND COMMUNICATIONS
11. RS-485 SERIAL PORTS, CABLING, AND COMMUNICATIONS
12. ETHERNET PORTS, CABLING, ADDRESSING, ROUTING, AND COMMUNICATIONS
13. ANALOG INPUTS (EG. 4-20 MILLIAMP) (IF APPLICABLE)
14. DIGITAL I/O AND SOLID-STATE RELAYS (IF APPLICABLE)
15. RADIO INTEGRATION (IF APPLICABLE)
16. CELLULAR GATEWAY INTEGRATION (IF APPLICABLE)
17. RTU AND/OR PLC INTEGRATION (IF APPLICABLE)

B. TOOLS FOR INSTALLING AND TROUBLESHOOTING AN ETHERMETER:

1. NOTEBOOK COMPUTER EQUIPPED WITH SERIAL PORT
   Caution: Certain USB-Serial Converters do not support all serial port parameters, such as 7E1, 7O1, and 7N2. Typically, 8N1 is well-supported.
2. EIA-561 TO RS-232C ADAPTER (SCADAMETRICS PART NO. EM-ADAPT-NULL)
3. “HYPERTERMINAL” TERMINAL EMULATION SOFTWARE (OR EQUIVALENT)
4. ETHERNET PATCH CABLE
5. VOLTMETER / AMMETER
6. TWO (2) SMALL FLAT-HEAD SCREWDRIVERS
7. ONE (1) SMALL #1 PHILIPS SCREWDRIVER

C. TOOLS FOR ATTACHING DIN-RAIL TO A CONTROL PANEL:

1. DIN-RAIL (35MM RECOMMENDED)
2. DIN-RAIL CUTTER (EG. ATMCO LB-100)
3. POWER OR CORDLESS DRILL
4. THREAD-TAPPING TOOL SET
5. MACHINE SCREWS, WASHERS

3 SPECIFICATIONS

A. Meter Communications

Protocols:	Sensus Variable-Length: 4 to 8 Digit Sensus Fixed-Length: 4 to 6 Digit Neptune E-Coder Plus: 8 digit Neptune ProRead Basic: 3 to 6 digit
Protocol Recognition:	Auto-Detect
Flow Rate Calculation:	dV/dT (Fixed dT or Fixed dV)
Touch-Read Compatibility:	Yes, when optional filter installed. (See Touch-Read Compatibility Matrix.)

B. Serial Communications

Ports:	RS-232C (EIA-561 Jack) RS-485 (Phoenix Terminal)
Speed:	300 to 115200 bps
Port Parameters:	8N1, 7E1, 7O1, 7N2
Handshaking:	Fixed RTS, Null Modem, RTS/CTS, CD-Collision Avoidance, None
Industrial Protocols:	MODBUS/RTU, MODBUS/ASCII, DF1/FULL-DUPLEX DF1/RADIO-MODEM RAW ASCII, ADAM-4000 (ADAM-Version Only) REMOTE VFDisplay (VFDisplay-Version Only)
Setup Terminal:	ANSI, 25x80 char, 9600, 8N1

C. Ethernet Communications

Speed:	10 Mbps (10BaseT)
Addressing:	DHCP or Static IP
Web Server:	Yes
Ping Server:	Yes
Industrial Protocols:	MODBUS/TCP (4 Sockets), EtherNet/IP,PCCC-Encapsulation (4 Sockets), MODBUS/UDP
MAC ID:	IEEE-Assigned OUI: 00-1D-C8

D. Mechanical/Electrical/Environmental

Dimensions:	8.25” x 4.75” x 1.75”
Weight:	13.5 Ounces
Temperature Range:	-20C to +70C
Relative Humidity:	5% to 95%, Non-Condensing
Panel Mounts:	Two (2) Universal Din-Rail Clips
LCD Display:	2x16 Character, Backlit
Supply Voltage:	9 VDC to 36 VDC
Supply Current:	275 mA Max. (2.50 W Max.) Nominal: 85 mA @ 24 VDC, Nominal: 62 mA @ 24 VDC w/ Backlight OFF
Terminal Block Conductors:	16AWG Max, 26AWG Min.
Internal Power Efficiency:	76%, Typical
Circuit Protection:	Fused (1000mA) + 9 TVSS Diodes
Environmental:	ROHS-Compliant, Lead-free

E. Auxiliary Inputs/Outputs

Analog Inputs:	Two 4-20mA Inputs (9.6 bit A/D), 240 Ohm Loop Resistance Configurable as 0-5VDC (10bit A/D)
Aux Digital I/O:	Two (2): One Digital Output One Configurable As Digital Input Or Output. Output(s): TTL (0-5VDC) Output Input: TTL Dry-Contact Input
MODBUS Fn. Codes:	01 - Read Coil Status, 02 - Read Input Status, 03 - Read Holding Registers, 04 - Read Input Registers, 05 - Force Single Coil 15 - Force Multiple Coils
DF1 Codes:	Protected Typed Logical Read With 3 Address Fields Protected Typed Logical Write With 3 Address Fields
ADAM-4000 Fn. Codes: (ADAM-Version Only)	#AAn - Read Analog Inputs, $AA6 - Read Discrete Inputs, #AA1n0d - Write Discrete Output, $AAM - Read Device ID

F. Standards And Regulatory Compliances

Safety (US):	UL 60950-1 Recognition (MET Labs File No. E112874)
Safety (Canada):	CSA C22.2 No. 60950-1 Recognition (MET Labs File No. E112874)
Emissions (US):	FCC Part 15, Class A
Emissions (Canada):	ICES-003
Meter Interface:	AWWA C707-05
Environmental:	ROHS-Compliant, Lead-Free
Manufacturing Location:	USA

G. Safety Considerations And Warnings

The following warnings and guidelines should be followed in order to ensure safe operation of your EtherMeter:

- Do not attempt to service the internal circuitry of the EtherMeter. This device contains no user-serviceable parts or adjustments.
- Carefully inspect the work area in which the EtherMeter will be located to ensure against hazards such as damp floors, ungrounded power extension cords, and missing ground connections.
- Before operating the EtherMeter, ensure that the external power source is an NRTL-listed power supply that is rated for a DC voltage between 9 and 36 VDC and rated for a minimum current of 275 mA. If you are not sure of the type of power source, contact your vendor or SCADAmetrics.
- The secondary output circuits of the EtherMeter are SELV (Safety Extra Low Voltage). Ensure that the secondary output circuits are not connected with hazardous energy levels.
- The EtherMeter has been evaluated and NRTL-recognized for use in a Pollution Degree 2 environment.
- The EtherMeter must be examined for compliance with the applicable safety standard after installation into the final enclosure.
- The EtherMeter must be installed in accordance with all applicable local electrical codes.
- If the EtherMeter is exposed to moisture or condensation, disconnect it from the power source immediately and obtain service assistance.
- If the EtherMeter exhibits unexpected behavior, such as smoking or becoming extremely hot, disconnect it from power sources immediately and then obtain service assistance.
- Ensure that the EtherMeter's cover is secure on completion of installation to reduce safety hazards.

H. Environmental Considerations and Cautions

The following is a list of environmental considerations that will help ensure safe and efficient operation of your EtherMeter:

- Do not position the EtherMeter near high-powered radio transmitters or electrical equipment, such as electrical motors or air conditioners. Interference from electrical equipment can cause intermittent failures.
- Do not install the EtherMeter in areas where condensation, water, or other liquids may be present. These may cause safety hazards and equipment failure.

I. FCC Class A Notice

This device complies with Part 15 of the FCC Rules.
Operation is subject to the following two conditions:

1. This device may not cause harmful interference.
2. This device must accept any interference received, including interference that may cause undesired operation.

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy, and if it is not installed and used in accordance with the instruction manual, it may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense. Modifications: Any modifications made to this device that are not approved by SCADAmetrics may void the authority granted to the user by the FCC to operate this equipment.

Report: http://scadametrics.com/PDF/EMC26372-FCC.pdf

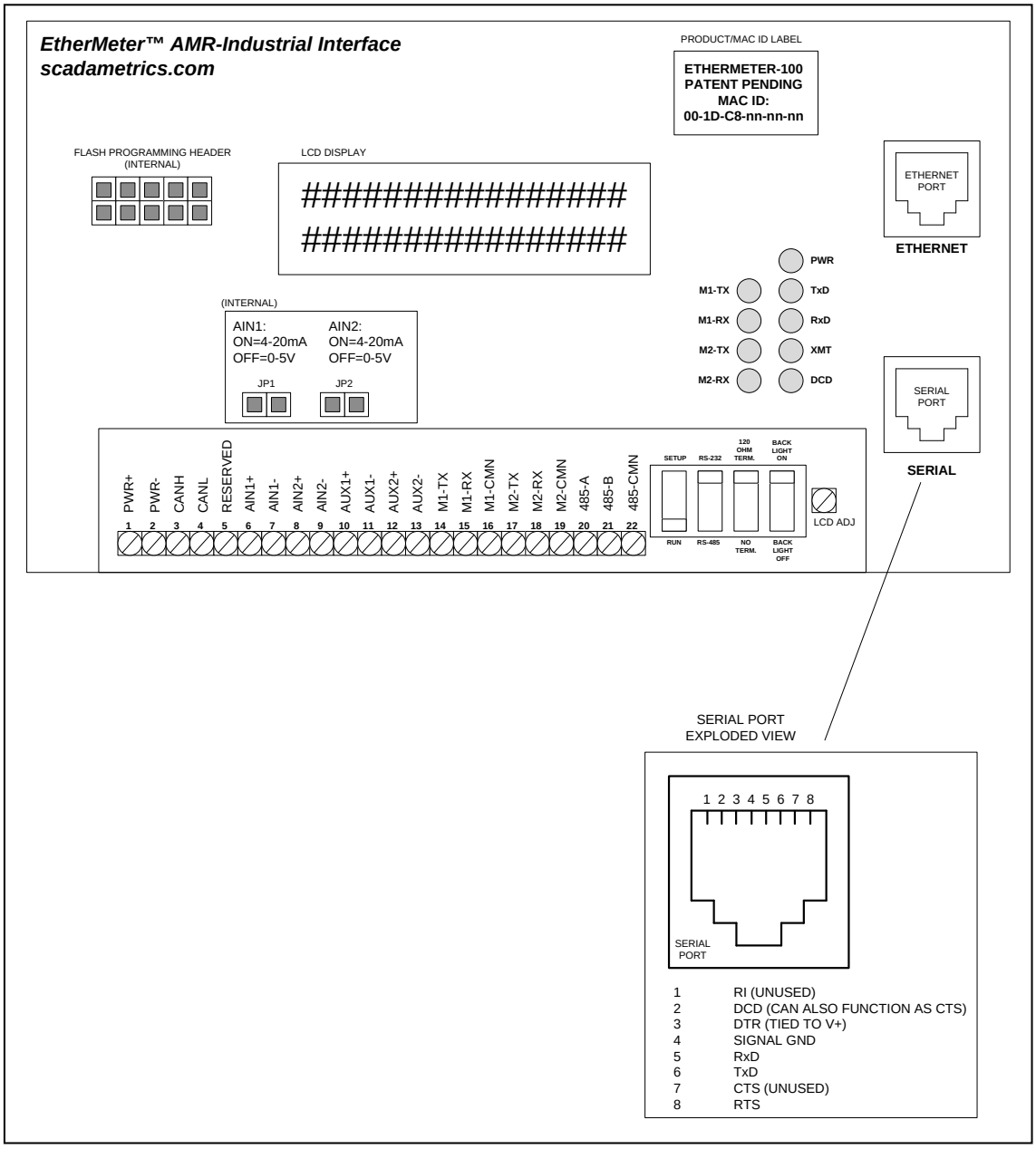
J. ICES Notice (Canada)

This Class [1] digital apparatus complies with Canadian ICES-003.

Report: http://scadametrics.com/PDF/EMC26372-IC.pdf

4 ELECTRICAL INTERFACE

Hookup Wiring Diagram:



POWER AND GROUNDING NOTES:

1. The EtherMeter requires a 9-36 VDC Power Supply (2.50 W Max). It is recommended that the common of the DC power supply be bonded to earth ground.

2. All connected communication equipment must utilize the same ground reference. To achieve this, a low-impedance ground bus wire should be tied to the DC common of each connected communication device.

DIP SWITCH DEFINITIONS:

#1	#2	#3	#4
UP SETUP MODE	**UP** RS-232C SERIAL PORT ACTIVE. RS-485 SERIAL PORT INACTIVE.	**UP** 120 OHM TERMINATION RESISTOR ACTIVE. (RS-485 ONLY)	**UP** LCD BACKLIGHT ON, POWER LED ON
DOWN RUN MODE	**DOWN** RS-485 SERIAL PORT ACTIVE RS-232C SERIAL PORT INACTIVE.	**DOWN** 120 OHM TERMINATION RESISTOR INACTIVE. (RS-485 ONLY)	**DOWN** LCD BACKLIGHT OFF, POWER LED OFF (POWER SAVING MODE)

LCD CONTRAST ADJUST:

The LCD contrast adjust potentiometer, located to the right of the dip switches, is set at the factory for room-temperature conditions. However, depending upon local temperature conditions, this potentiometer may require adjustment. A small, flat head screwdriver is required for adjustment.

5 METER COMPATIBILITY MATRIX

The following compatibility matrix is by no means exhaustive, especially in light of the fact that there are a multitude of three-wire-protocol registers available on the market today. Advertised full compatibility is limited to registers deemed so based upon testing within the laboratory and/or the field; and those are denoted by the EtherMeter™ logo:

If there is a Sensus-protocol or Neptune-protocol encoder meter register that is not listed as compatible based upon testing, and you would like to see it listed as such, then please contact *SCADAmetrics*. Note that in such cases, we may request a register for testing and verification.

If there is a Sensus-protocol or Neptune-protocol encoder meter register that is not listed as compatible based upon testing, and you would like to see it listed as such, then please contact SCADAmetrics. Note that in such cases, we may request a register for testing and verification.

Make	Model	Notes
Badger	**ADE®**	**Compatible (based upon laboratory and/or field testing).** **Test Register provided courtesy of Badger Meter.** Good register for SCADA System interrogation of encoder register. Provides medium-resolution totalization (6 digits). The medium-resolution totalization delays flow-rate calculations and reverse-flow detection. (The "FIXED DTOTAL" flow calculation method is recommended.) Does not contain or require a battery, as it draws its power from the interrogation device. Can be interrogated every 8 seconds (328,500 times per month), with no apparent wear. Register requires factory pre-programming. The maximum (6 digits) is recommended. Wiring Color Codes: RED=TX, GREEN=RX, BLACK=CMN
Elster AMCO (ABB/Kent)	**InVISION™ Sensus-Protocol Option**	**Compatible (based upon laboratory and/or field testing).** **Test Register provided courtesy of Bond-Madison Water District.** Good register for SCADA System interrogation of encoder register. Provides medium-resolution totalization (6 digits). The medium-resolution totalization delays flow-rate calculations and reverse-flow detection. (The "FIXED DTOTAL" flow calculation method is recommended.) Does not contain or require a battery, as it draws its power from the interrogation device. Can be interrogated every 8 seconds (328,500 times per month), with no apparent wear. Register requires factory pre-programming. The maximum (6 digits) is recommended. Wiring Color Codes: RED=TX, GREEN=RX, BLACK=CMN

Elster AMCO (ABB/Kent)	**evoQ4** **Mag-Meter** **Sensus-Protocol Option**	**Likely Compatible (based upon published specifications).** Excellent register for SCADA System interrogation of encoder register. Provides high-resolution totalization (8 digits). The high-resolution totalization speeds the flow-rate calculation and detection of reverse flows. Provides accurate measurement of bi-directional flow-rate and totalization. Battery-powered (10-year battery life). Register requires user/factory pre-programming. The maximum (8 digits) is recommended. Wiring Color Codes: RED=TX, GREEN=RX, BLACK=CMN
Hersey	**Translator** 	**Compatible (based upon laboratory and/or field testing).** **Test Register provided courtesy of Hersey Meter.** Good register for SCADA System interrogation of encoder register. Provides medium-resolution totalization (6 digits). The medium-resolution totalization delays flow-rate calculations and reverse-flow detection. (The "FIXED DTOTAL" flow calculation method is recommended.) Does not contain or require a battery, as it draws its power from the interrogation device. Can be interrogated every 8 seconds (328,500 times per month), with no apparent wear. Register requires factory pre-programming. The maximum (6 digits) is recommended. Wiring Color Codes: RED=TX, WHITE=RX, BLACK=CMN
Itron (Actaris)	**Cyble™ Coder** 	**Compatible (based upon laboratory and/or field testing).** **Test Register provided courtesy of Actaris.** Excellent register for SCADA System interrogation of encoder register. Provides high-resolution totalization (8 digits). The high-resolution totalization speeds the flow-rate calculation and detection of reverse flows. Contains an internal battery, but the battery is not depleted with each interrogation. Therefore can be interrogated every 8 seconds without degrading battery life. The battery is rated for 12 years. After the battery is depleted, the register and Cyble™ Coder must be replaced. Can be interrogated every 8 seconds (328,500 times per month), with no apparent wear. Register requires factory pre-programming. The maximum (8 digits) is recommended. Wiring Color Codes: RED=TX, GREEN=RX, BLACK=CMN

Master Meter	**Acculinx™**	**Likely Compatible (based upon published specifications).** Excellent register for SCADA System interrogation of encoder register. Provides high-resolution totalization (8 digits). The high-resolution totalization speeds the flow-rate calculation and detection of reverse flows. Does not contain or require a battery, as it draws its power from the interrogation device. Register requires factory pre-programming. The maximum (8 digits) is recommended. Wiring Color Codes: RED=TX, GREEN=RX, BLACK=CMN
Metron Farnier	**HawkEye™ OER** 	**Compatible (based upon laboratory and/or field testing).** **Test Register provided courtesy of Metron Farnier.** **(Note: The 6-digit (newest) version of this register is recommended.)** Good register for SCADA System interrogation of encoder register. Provides medium-resolution totalization (6 digits). The medium-resolution totalization delays flow-rate calculations and reverse-flow detection. (The "FIXED DTOTAL" flow calculation method is recommended.) Does not contain or require a battery, as it draws its power from the interrogation device. Can be interrogated every 8 seconds (328,500 times per month), with no apparent wear. Register requires factory pre-programming. The maximum (6 digits) is recommended. Wiring Color Codes: RED=TX, WHITE=RX, BLACK=CMN
Metron Farnier	**MIU (Register Attachment)** 	**Compatible (based upon laboratory and/or field testing).** **Test Register provided courtesy of Metron Farnier.** Good register for SCADA System interrogation of encoder register. Provides medium/high-resolution totalization (7 digits). The medium/high-resolution totalization speeds the flow-rate calculation. Reverse-flows can cause erroneous readings and are not detected with this register. Contains an internal battery, but the battery is not depleted with each interrogation. Can be interrogated every 8 seconds (328,500 times per month), with no apparent wear. Register requires factory pre-programming. The maximum (7 digits) is recommended. Wiring Color Codes: RED=TX, WHITE=RX, BLACK=CMN

Neptune (Schlumberger)	**E-Coder™**	**Compatible (based upon laboratory and/or field testing).** **Test Registers provided courtesy of Neptune Technology Group.** Excellent register for SCADA System interrogation of encoder register. Provides high-resolution totalization (8 digits). The high-resolution totalization speeds the flow-rate calculation and detection of reverse flows. Does not contain or require a battery, as it draws its power from the interrogation device. Can be interrogated every 8 seconds (328,500 times per month), with no apparent wear. Register does not require any special factory pre-programming (Factory Defaults = OK). Wiring Color Codes: BLACK=TX, RED=RX, GREEN=CMN
Neptune (Schlumberger)	**ProRead™ "Auto"**	**Compatible (based upon laboratory and/or field testing).** **Test Registers provided courtesy of Neptune Technology Group.** Fair register for SCADA System interrogation of encoder register. Provides low/medium-resolution totalization (5.2 digits). The low/medium-resolution totalization delays flow-rate calculations and reverse-flow detection. (The "FIXED DTOTAL" flow calculation method is recommended.) Does not contain or require a battery, as it draws its power from the interrogation device. Can be interrogated every 8 seconds (328,500 times per month), with no apparent wear. Register requires factory pre-programming. The maximum (5.2 digits) is recommended. Wiring Color Codes: BLACK=TX, RED=RX, GREEN=CMN
Sensus (Rockwell/ Invensys)	**ICE® (ECR-III)**	**Compatible (based upon laboratory and/or field testing).** **Test Registers provided courtesy of Sensus Metering Systems.** Excellent register for SCADA System interrogation of encoder register. Provides high-resolution totalization (8 digits). The high-resolution totalization speeds the flow-rate calculation and detection of reverse flows. Does not contain or require a battery, as it draws its power from the interrogation device. Can be interrogated every 8 seconds (328,500 times per month), with no apparent wear. Register requires factory pre-programming. The maximum (8 digits) is recommended. Wiring Color Codes: RED=TX, GREEN=RX, BLACK=CMN

Sensus (Rockwell/ Invensys)	**OMNI T^2 Turbo, C^2 Compound, F^2 Fire Service** 	**Compatible (based upon laboratory and/or field testing).** **Test Registers provided courtesy of Sensus Metering Systems.** Excellent register for SCADA System interrogation of encoder register. Provides high-resolution totalization (8 digits). The high-resolution totalization speeds the flow-rate calculation and detection of reverse flows. Contains a battery, although SCADAmetrics laboratory tests demonstrated that frequent interrogations do not degrade the register's battery life. Register requires factory pre-programming. The maximum (8 digits) is recommended. Wiring Color Codes: RED=TX, GREEN=RX, BLACK=CMN
Sensus (Rockwell/ Invensys)	**ECR** 	**Compatible (based upon laboratory and/or field testing).** **Test Registers provided courtesy of Sensus Metering Systems.** **(Note 1: Register Utilizes The "Fixed-Length" Variation Of The Sensus Protocol.)** **(Note 2: Obsolete Register, No Longer Available From Sensus. SCADAmetrics recommends replacement with ICE® Register.)** Fair register for SCADA System interrogation of encoder register. Provides low resolution totalization (4 digits). The low -resolution totalization delays flow-rate calculations and reverse-flow detection. (The "FIXED DTOTAL" flow calculation method is recommended.) Does not contain or require a battery, as it draws its power from the interrogation device. Can be interrogated every 8 seconds (328,500 times per month), with no apparent wear. Register does not require factory pre-programming. Wiring Color Codes: RED=TX, GREEN=RX, BLACK=CMN
Siemens (Sitrans)	**F M MAG 8000** **Mag-Meter** **Sensus Protocol Option**	**Likely Compatible (based upon published specifications).** Excellent register for SCADA System interrogation of encoder register. Provides high-resolution totalization (8 digits). The high-resolution totalization speeds the flow-rate calculation and detection of reverse flows. This mag-meter provides accurate measurement of bi-directional flow-rate and totalization. Battery-powered. Alternatively, may be externally-powered plus outfitted with an internal backup battery. Register requires user/factory pre-programming. The maximum (8 digits) is recommended. Wiring Codes: TX=TERM.91, RX=TERM.92, CMN=TERM.93

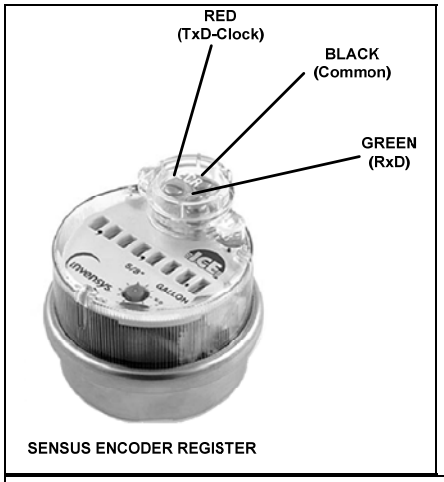
6 SENSUS-PROTOCOL METER SUPPORT

The Sensus Protocol, as implemented within the Sensus ICE™ and OMNI T2 registers, the Badger ADE register, and numerous compatibles, is fully supported by the EtherMeter.

Important Notes:

(1) Most Sensus-compatible registers do not provide the maximum resolution (digits) by default, and therefore may require factory pre-programming. See the Meter Compatibility Matrix for configuration details.

(2) Wire color-coding for Sensus-compatibles varies among meter brands. See the Meter Compatibility Matrix for details.



SENSUS ENCODER REGISTER

SENSUS PROTOCOL:

7 DATA BITS, 1 START BIT, 1 STOP BIT, EVEN PARITY, ASCII ENCODING

SAMPLE READ. TOTALIZATION = 99999987

V ; R B 9 9 9 9 9 9 8 7 ; I B L O T 0 3 0 1 1 5 <CR>

START DELIMITER — TOTALIZATION DATA (DIGITS 1-N) — TERMINATION DELIMITER

Sensus ICE™ – Register Diagram. **Sensus – Protocol Diagram Example (Total="99999987").**

To connect a Sensus-Protocol Register to Meter Channel 1:

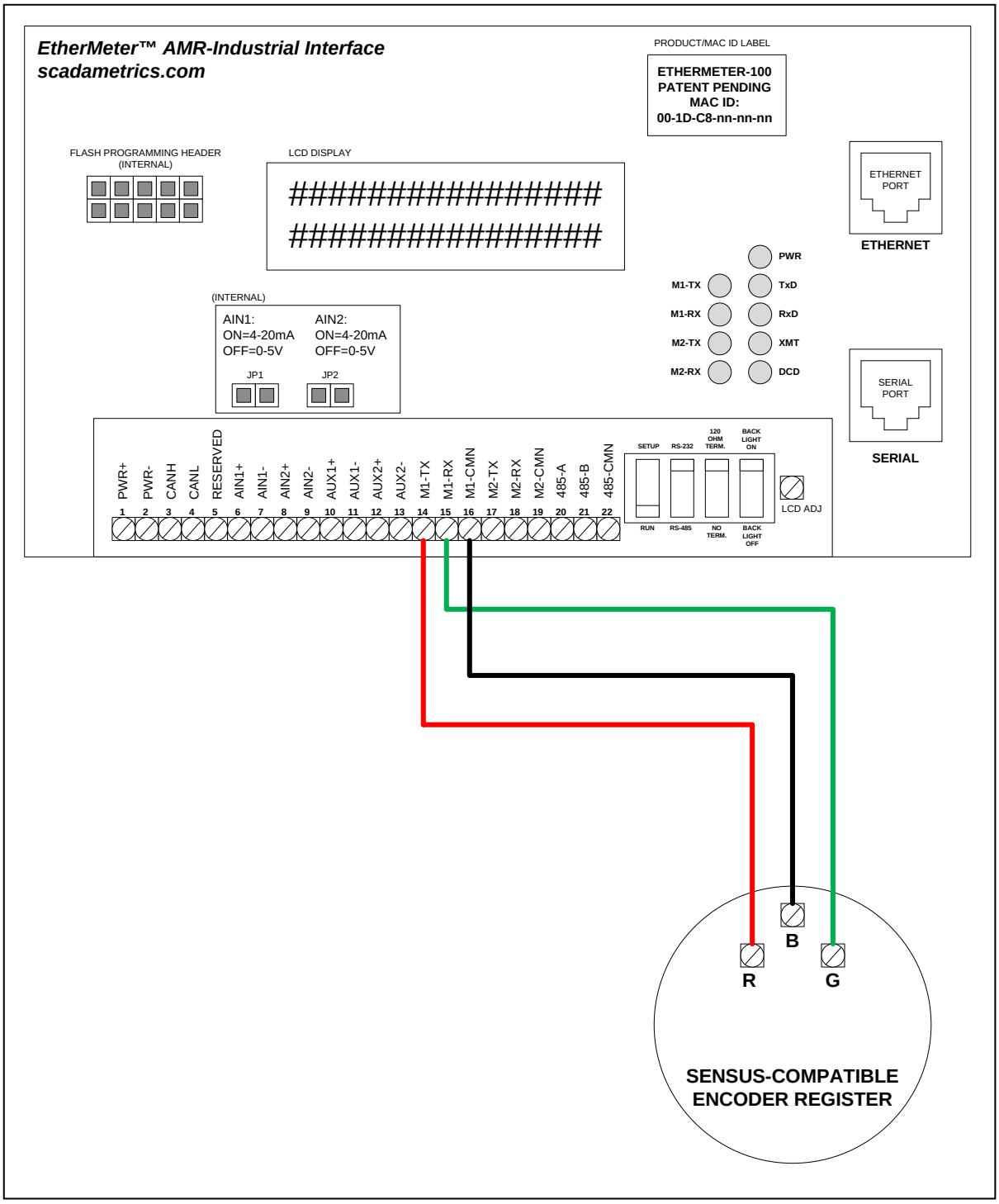
EtherMeter Terminal	Sensus-Compatible Wire Color* *Note: Color codes may vary by meter brand. See Meter Compatibility Matrix for details.
14	Red
15	Green
16	Black

To connect a Sensus-Protocol Register to Meter Channel 2:

EtherMeter Terminal	Sensus-Compatible Wire Color* *Note: Color codes may vary by meter brand. See Meter Compatibility Matrix for details.
17	Red
18	Green
19	Black

METER HOOKUP FOR SENSUS-COMPATIBLE REGISTERS:

The following diagram demonstrates the hookup of a Sensus-compatible encoder register to Meter Channel 1 of the EtherMeter. Terminals 14, 15, and 16 are used in this case. Hookup to Meter Channel 2 will be identical, except terminals 17, 18, and 19 are used.



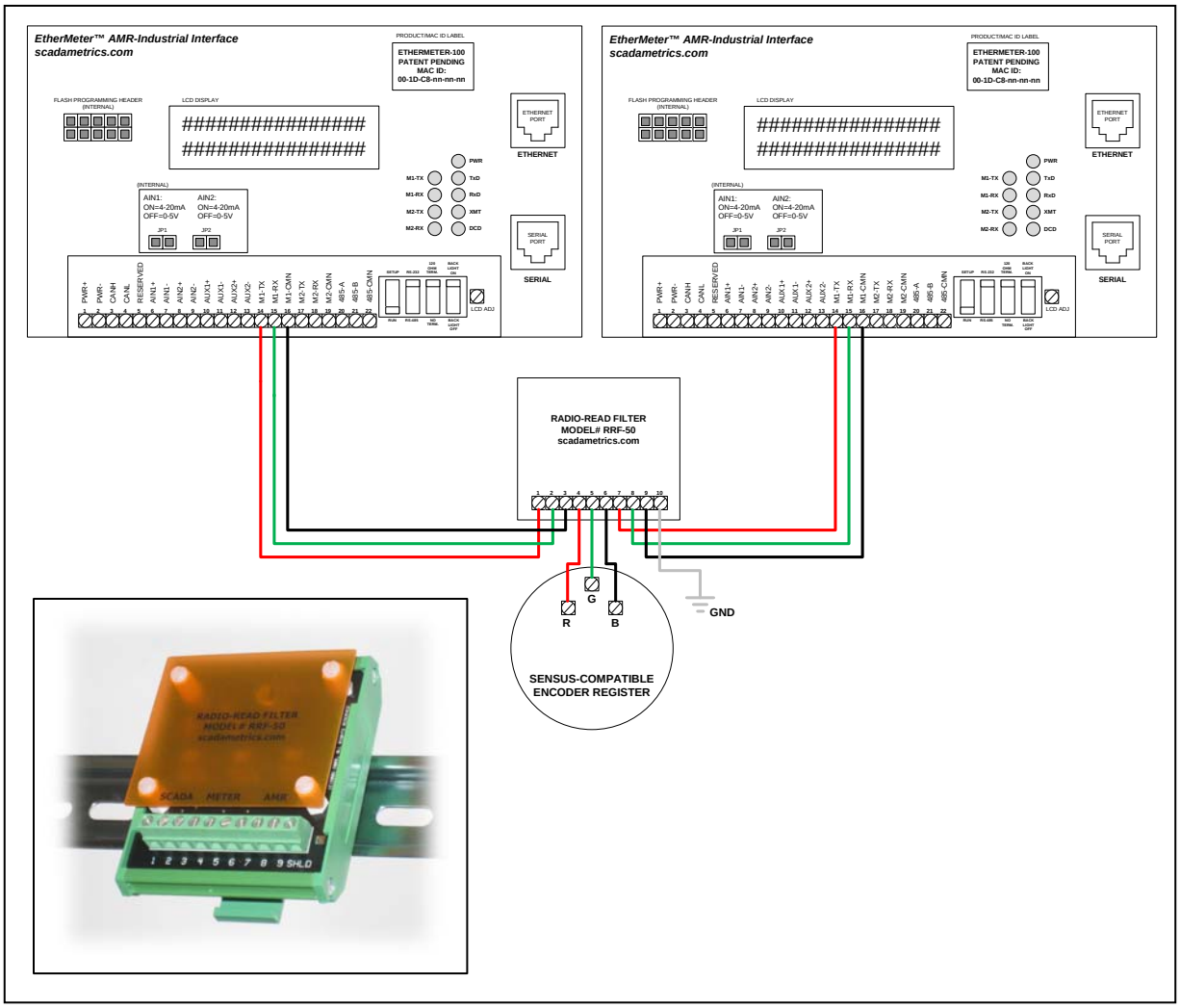
PARALLEL ETHERMETER HOOKUP FOR SENSUS-COMPATIBLE REGISTERS:

Two EtherMeters may be connected in parallel to a single meter register with the aid of the Radio-Read Filter (SCADAMETRICS P/N RRF-50).

The following diagram demonstrates the hookup of a Sensus-compatible encoder register to two EtherMeters. In this example, terminals 14, 15, and 16 are used on both EtherMeters (Meter Channel 1). However, either channel may be used on each EtherMeter. Check the Meter Compatibility Matrix on scadametrics.com, in advance, to ensure compatibility.

In the place of the second (rightmost) EtherMeter in the diagram, a three-wire AMR device may be installed. Examples include the Sensus MXU, Neptune R900, Itron ERT, and many others.

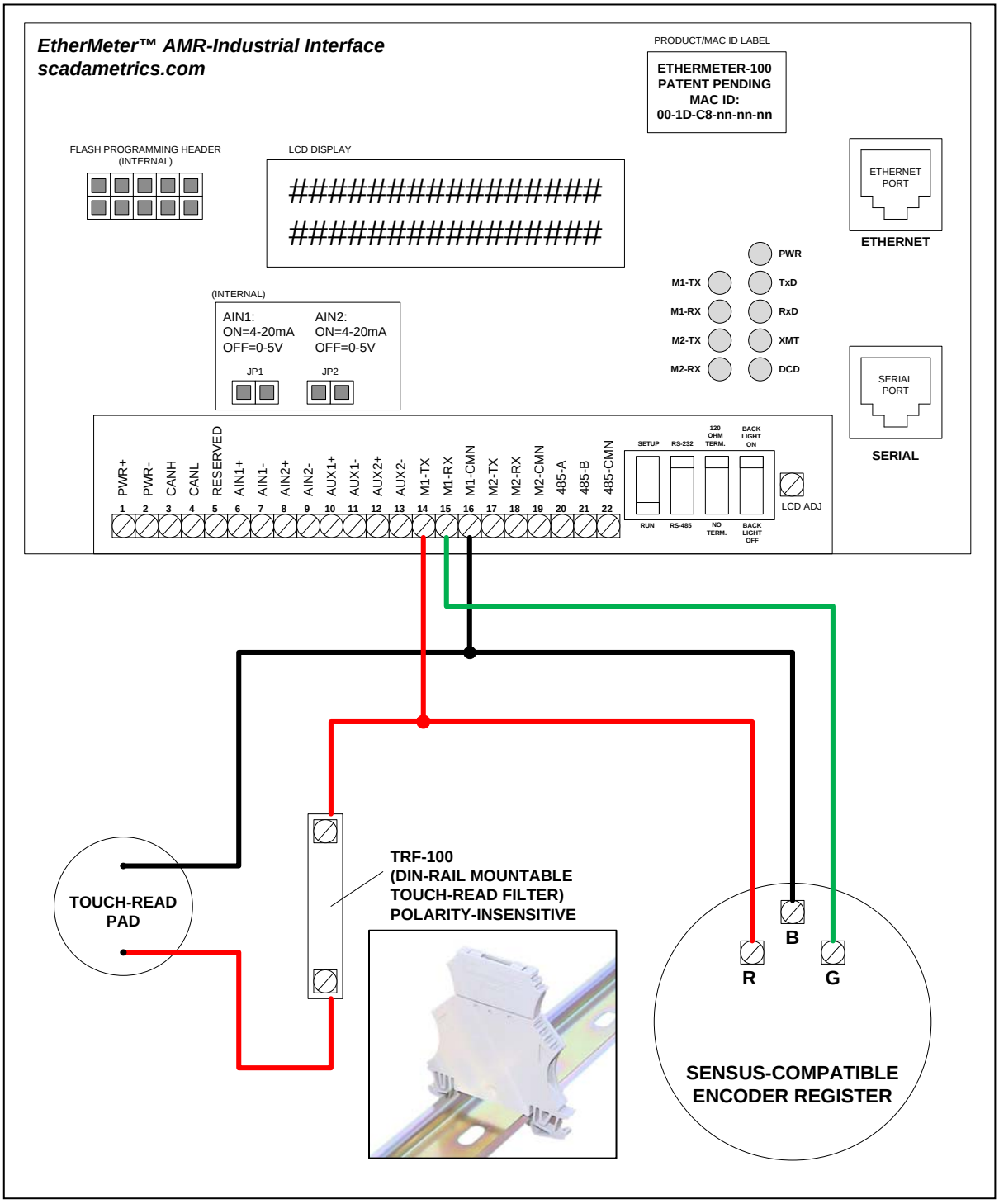
It is important to note that the Radio-Read Filter derives all necessary power from the first (leftmost) EtherMeter in the diagram. No external power supply is required.



PARALLEL TOUCH-READ HOOKUP FOR SENSUS-COMPATIBLE REGISTERS:

The EtherMeter may be connected to a meter register in parallel with a touch-read pad. However, the addition of a signal filter is required (SCADAMETRICS P/N TRF-100).

The following diagram demonstrates the hookup of a Sensus-compatible encoder register to Meter Channel 1 of the EtherMeter, and in parallel with an inductive touch-read pad. Terminals 14, 15, and 16 are used in this case. Hookup to Meter Channel 2 will be identical, except terminals 17, 18, and 19 are used. Check the Touch-Read Filter Compatibility Matrix on scadametrics.com, in advance, to ensure compatibility.



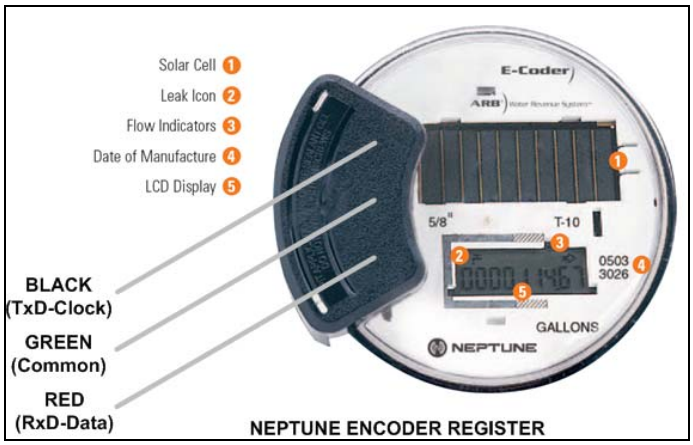
7 NEPTUNE-PROTOCOL METER SUPPORT

The Neptune Protocol, as implemented within the E-Coder™ and ProRead line of registers, is fully supported by the EtherMeter.

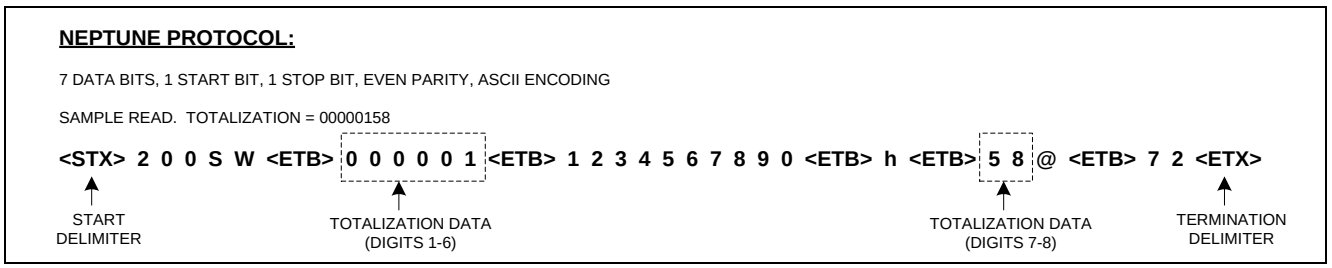
Important Notes:

(1) See the Meter Compatibility Matrix for meter register configuration details.

(2) Wire color-coding for Neptune-compatibles differs from that used in Sensus-compatibles.



Neptune E-Coder™ – Register Diagram.



Neptune – Protocol Diagram Example (Total=”00000158”).

To connect a Neptune-Protocol Register to Meter Channel 1:

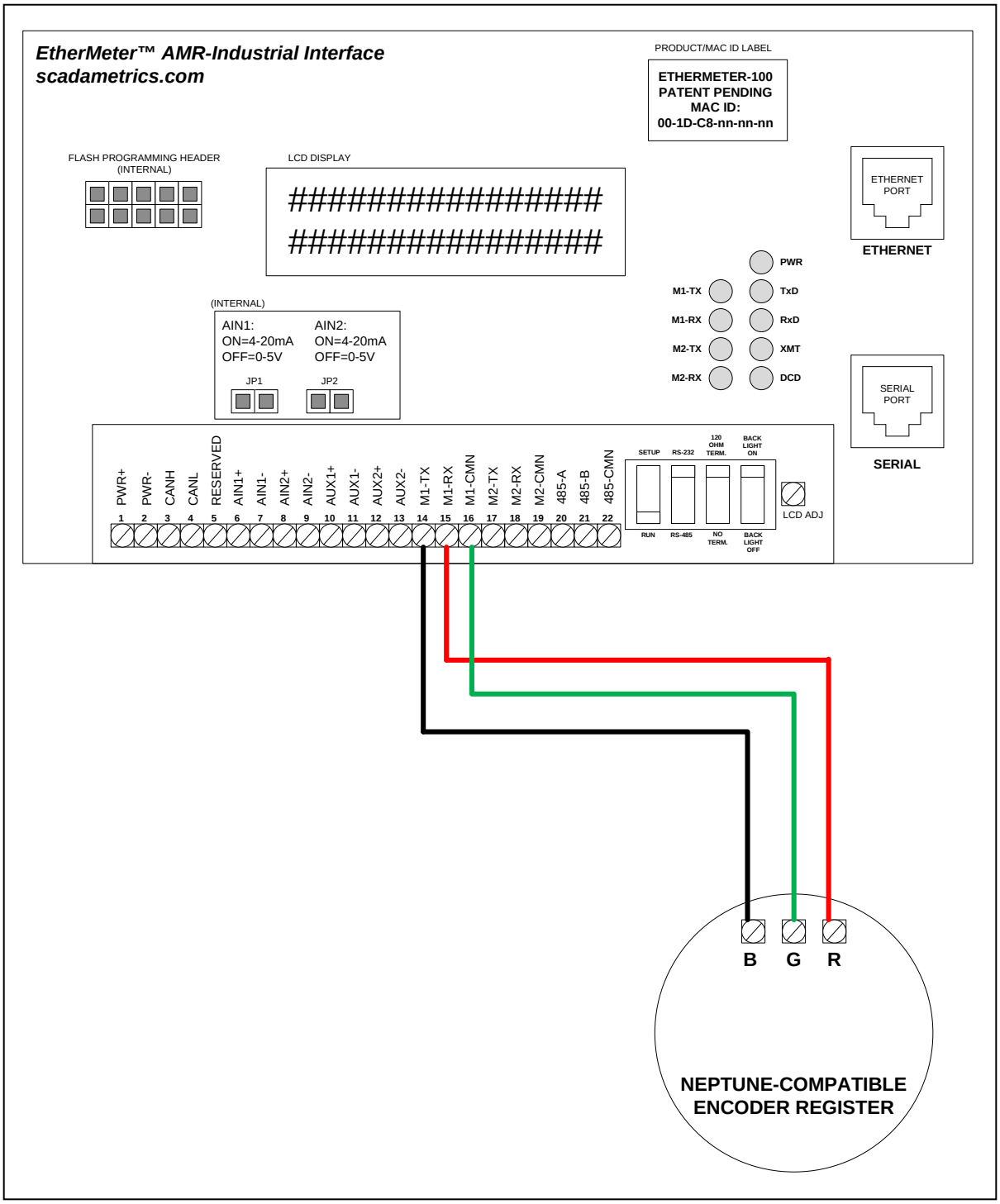
EtherMeter Terminal	Neptune-Compatible Wire Color
14	Black
15	Red
16	Green

To connect a Neptune-Protocol Register to Meter Channel 2:

EtherMeter Terminal	Neptune-Compatible Wire Color
17	Black
18	Red
19	Green

METER HOOKUP FOR NEPTUNE-COMPATIBLE REGISTERS:

The following diagram demonstrates the hookup of a Neptune-compatible encoder register to Meter Channel 1 of the EtherMeter. Terminals 14, 15, and 16 are used in this case. Hookup to Meter Channel 2 will be identical, except terminals 17, 18, and 19 are used.



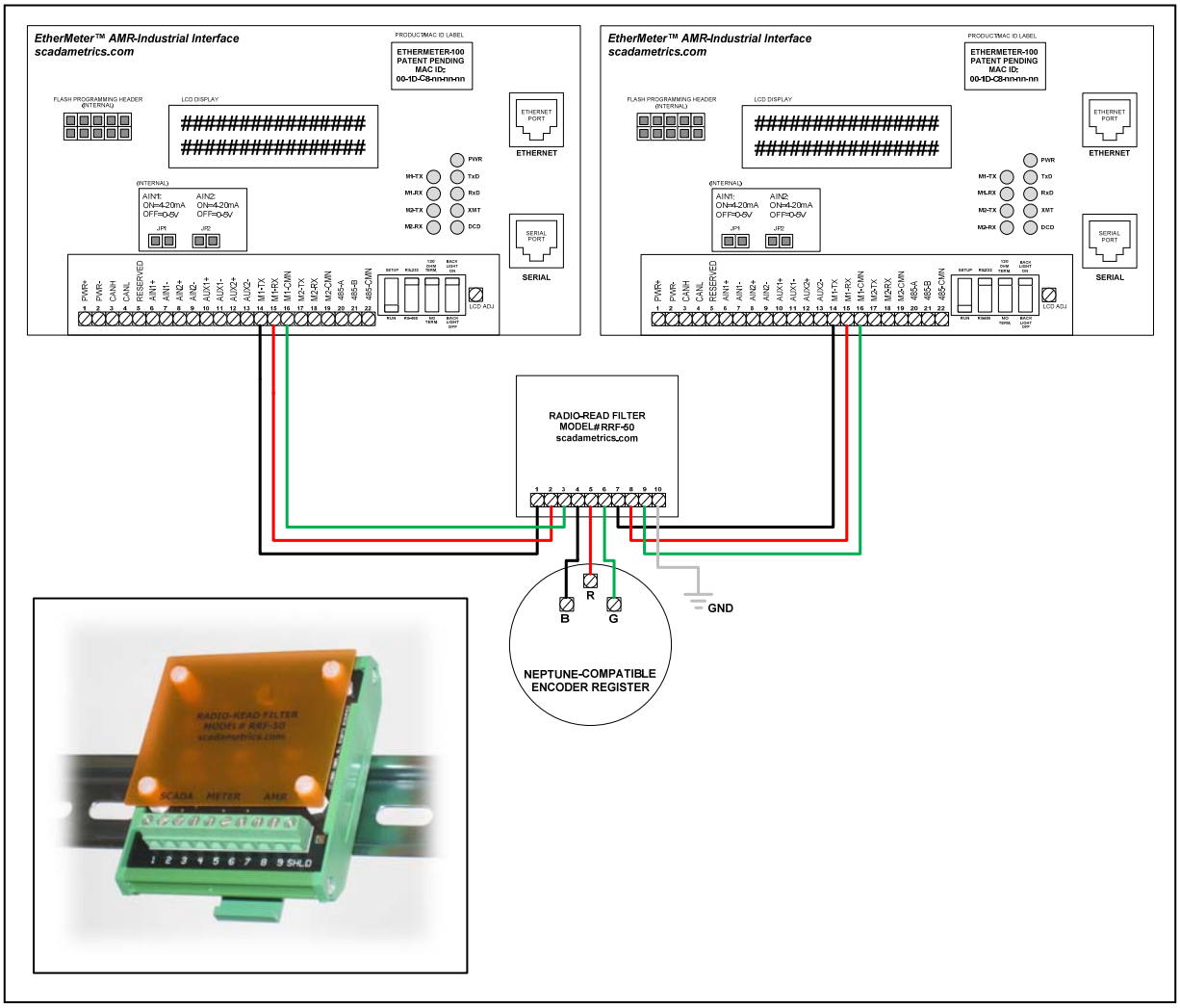
PARALLEL ETHERMETER HOOKUP FOR NEPTUNE-COMPATIBLE REGISTERS:

Two EtherMeters may be connected in parallel to a single meter register with the aid of the Radio-Read Filter (SCADAMETRICS P/N RRF-50).

The following diagram demonstrates the hookup of a Neptune-compatible encoder register to two EtherMeters. In this example, terminals 14, 15, and 16 are used on both EtherMeters (Meter Channel 1). However, either channel may be used on each EtherMeter. Check the Meter Compatibility Matrix on scadametrics.com, in advance, to ensure compatibility.

In the place of the second (rightmost) EtherMeter in the diagram, a three-wire AMR device may be installed. Examples include the Sensus MXU, Neptune R900, Itron ERT, and many others

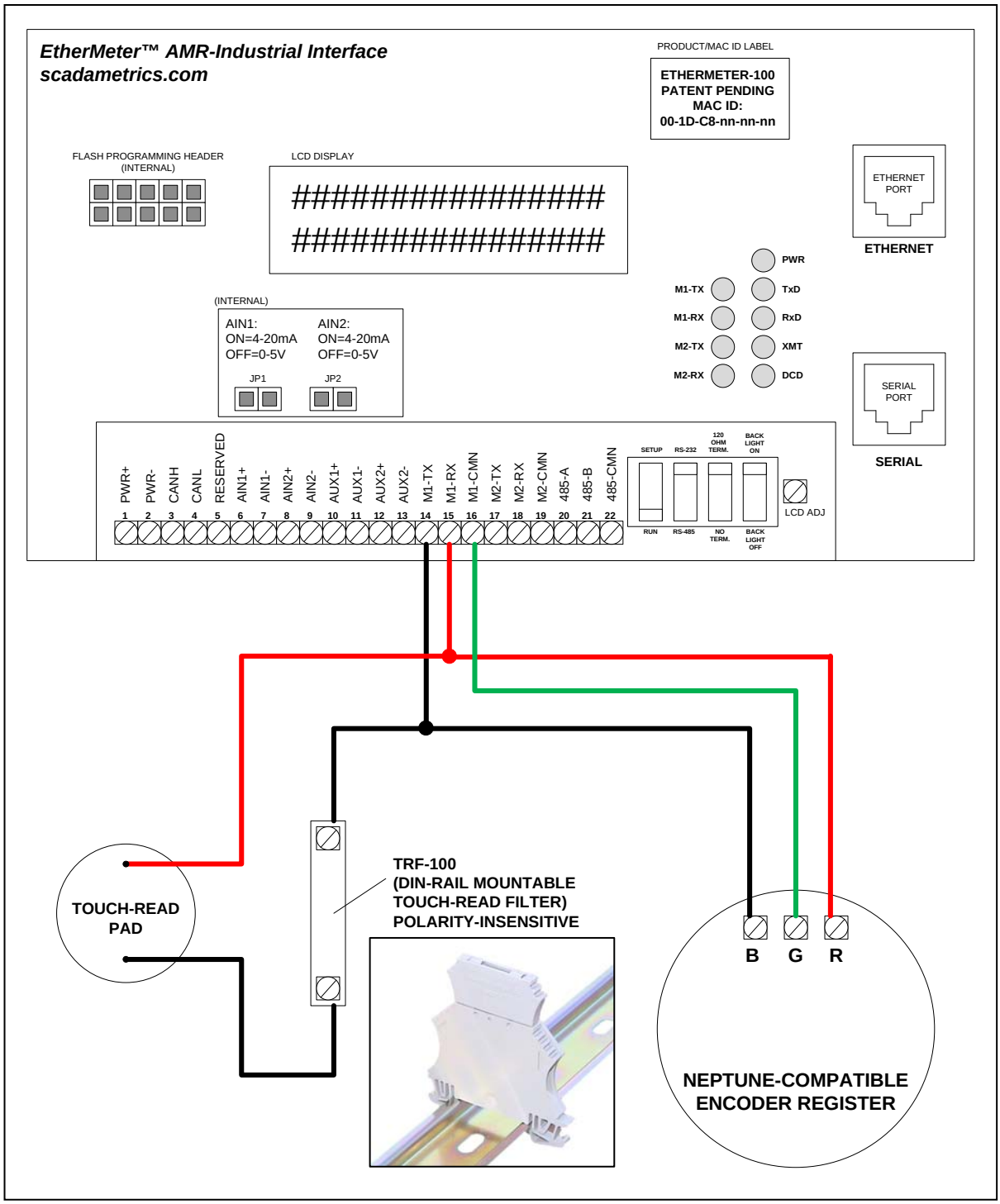
It is important to note that the Radio-Read Filter derives all necessary power from the first (leftmost) EtherMeter in the diagram. No external power supply is required.



PARALLEL TOUCH-READ HOOKUP FOR NEPTUNE-COMPATIBLE REGISTERS:

The EtherMeter may be connected to a meter register in parallel with a touch-read pad. However, the addition of a signal filter is required (SCADAMETRICS P/N TRF-100).

The following diagram demonstrates the hookup of a Neptune-compatible encoder register to Meter Channel 1 of the EtherMeter, and in parallel with an inductive touch-read pad. Terminals 14, 15, and 16 are used in this case. Hookup to Meter Channel 2 will be identical, except terminals 17, 18, and 19 are used. Check the Touch-Read Filter Compatibility Matrix on scadametrics.com, in advance, to ensure compatibility.



8 PLC/RTU/COMPUTER INTERFACE

There are currently three (3) physical types of signal connections that can be made between a PLC/RTU/Computer and the EtherMeter.

- RS-232C Serial
- RS-485 Serial
- Ethernet

CAUTION:

The EtherMeter utilizes an RJ-45 jack for the RS-232C serial port **AND** another RJ-45 jack for the Ethernet port. The device was intentionally designed in this manner so as to reduce the number of cable types required by the SCADA Integrator. However, it is imperative that the serial port not be mistaken for the Ethernet port, and vice versa.

The serial port is designated with the marking "SERIAL" directly beneath it, and the Ethernet port is designated with the marking "ETHERNET" directly beneath it.

Plugging a serial device into the Ethernet port and/or plugging an Ethernet device into the serial port may cause irreversible damage to the EtherMeter and/or the connecting equipment. Please proceed with due care and caution when hooking up to the ports.

RS-232C Serial Port

The RS-232C serial port is implemented within a RJ-45 modular jack and conforms to the EIA-561 standard. The pinout is as described in Section 4.

In order to activate the RS-232C serial port, the 2nd dip switch should be placed in the "up" position. Note that either the RS-232C or RS-485 serial port can be activated, but not both simultaneously.

It is important to note that the RS-232C serial port is not optically-isolated, and therefore port isolation and/or TVSS may be required in certain situations.

When connecting a PLC/RTU/PC/RADIO to the RS-232C serial port of the EtherMeter, the modular adapters manufactured by QVS are highly recommended:

QVS Modular Jack Utility Matrix		
Function	**QVS Part#**	**Photo**
RJ-45 to DB9F	CC-439	
RJ-45 to DB9M	CC-438	
RJ-45 to DB25F	CC-343	
RJ-45 to DB25M	CC-342	

Note the following QVS color codes as mapped to the RS-232C (EIA-561) Jack:

QVS ADAPTOR WIRE COLOR	FUNCTION	IMPLEMENTED IN THE ETHERMETER?
BLUE	RING INDICATOR	NO
ORANGE	DCD (OR CTS)	YES
BLACK	DTR	YES (TIED TO V+)
RED	SIG GND	YES
GREEN	RxD (DATA RECEIVED BY ETHERMETER)	YES
YELLOW	TxD (DATA TRANSMITTED BY ETHERMETER)	YES
BROWN	CTS	NO (BUT SEE DCD (ORANGE) ABOVE)
WHITE	RTS	YES

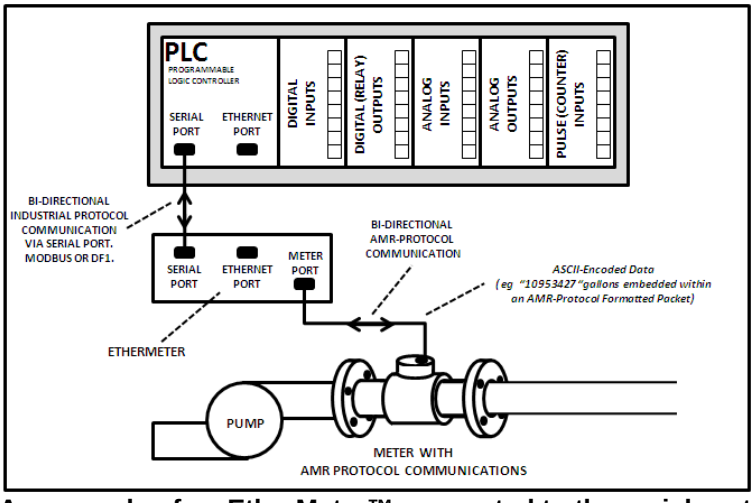
RS-485 Serial Port

The RS-485 serial port is implemented within three (3) Phoenix Contact screw terminals. The pinout is as described in Section 4.

In order to activate the RS-485 serial port, the 2nd dip switch should be placed in the "down" position. Note that either the RS-232C or RS-485 serial port can be activated, but not both simultaneously.

When the EtherMeter is staged at the endpoint of the transmission line, a 120 Ohm termination resistor should be used. For convenience, a 120 Ohm, ½ Watt resistor is included as a feature within the device. To activate the termination resistor, the 3rd dip switch should be placed in the "up" position. In all other cases, this resistor should be disabled with the dip switch in the "down" position.

A DC common reference terminal is included with the RS-485 port (terminal 22). This fused terminal is connected to the device's DC common through a 120 Ohm, ½ Watt current-limiting resistor. It is important to note that the RS-485 serial port is not optically-isolated, and therefore port isolation and/or TVSS may be required.



An example of an EtherMeter™ connected to the serial port of a PLC.

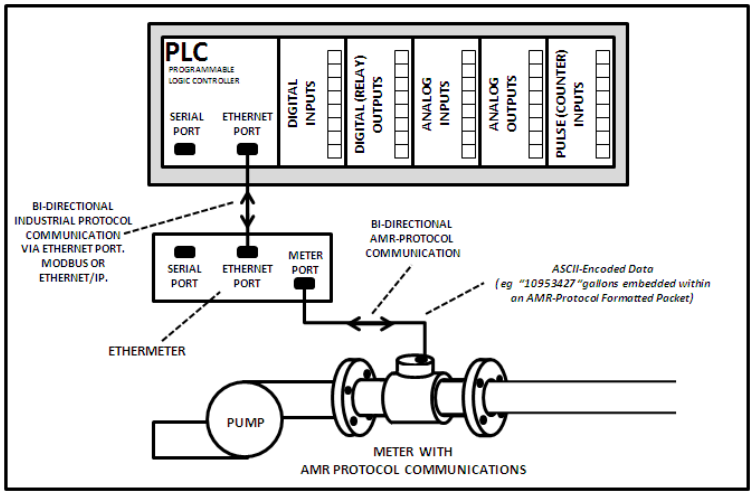
Ethernet Port

The Ethernet port is a 10BaseT modular jack, and operates at a maximum data rate of 10 Mbps. Both dynamic (DHCP) and static IP addressing are supported.

The Ethernet port supports the ARP ping function, serves a web page on TCP port 80, and provides a Telnet Server for remote configuration and troubleshooting.

MODBUS/TCP (4 sockets) is active at all times on TCP port 502, and MODBUS/UDP is active at all times on UDP port 502.

EtherNet/IP (4 sockets) is active at all times on TCP port 44818.



An example of an EtherMeter™ connected to the Ethernet port of a PLC.

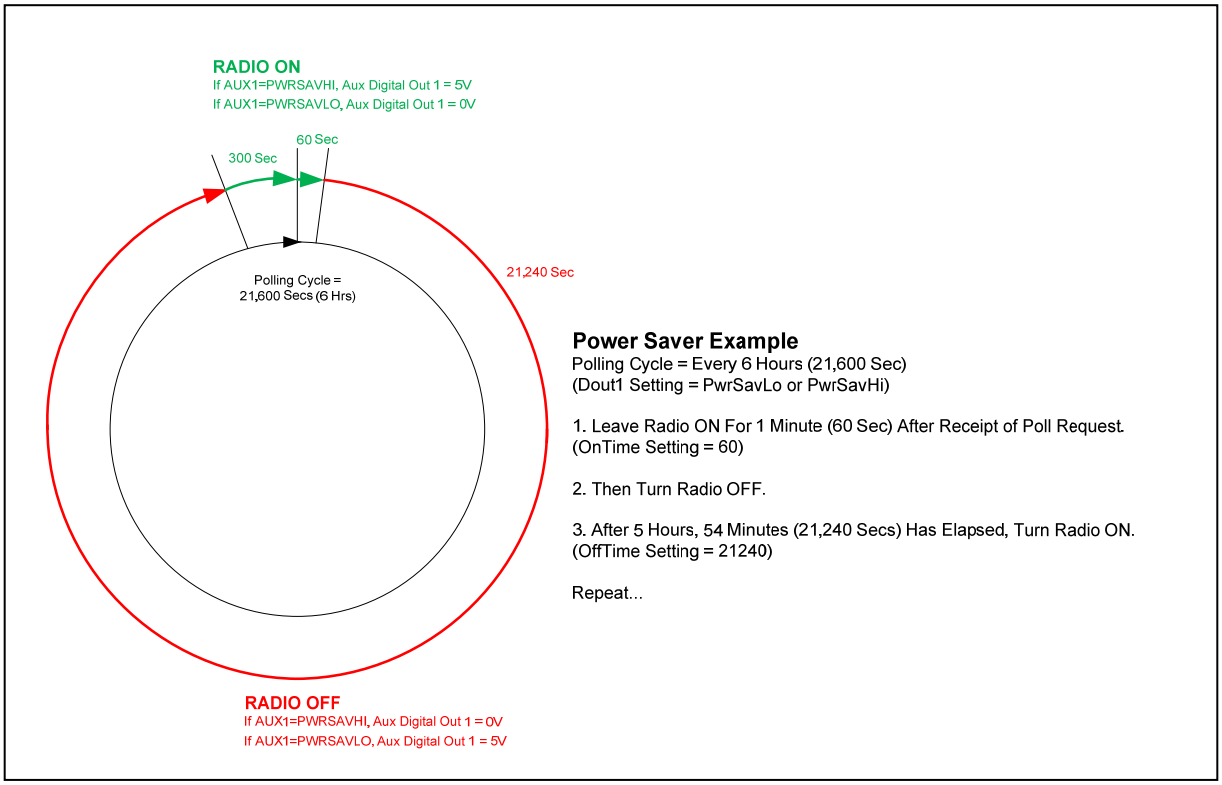
9 RADIO INTERFACE

Support is provided for direct connection to most popular industrial radio modems. Depending upon the radio, the connection may be made via the RS-232C or RS-485 serial port, or via the Ethernet port. Serial Port parameters may be tailored for the radio via the Settings Menu. The following list, although not exhaustive, enumerates some of the most popular, compatible industrial radio modems.

Microwave Data Systems	TransNet, entraNet, iNet, 1710, 2710, 4710, 4790, 9710, 9790
Maxstream	XTend-PKG 900 MHz, RS-232, Industrial or Commercial
Zlinx	ZP9D, ZP24D Series
Cirronet	HopNet Serial and Ethernet Series
Calamp/Dataradio	DL-3400, Integra-IP, Integra-TR, Integra-H, T96-SR, TSLM, JSLM, VIPR, HIPR
Calamp	819, 822, 882 Cellular Data Modems

Solar Energy-Saver Features:

The EtherMeter supports an energy-saver feature that may be useful in solar-powered applications. When the Dout1 setting is PwrSavLo or PwrSavHi, the 1st auxiliary digital output may be interfaced to a solid-state relay (or even directly to certain radio modems) to power down a radio between polling sessions. The operation is described through the following example:


RADIO ON
If AUX1=PWRSAVHI, Aux Digital Out 1 = 5V
If AUX1=PWRSAVLO, Aux Digital Out 1 = 0V
60 Sec
300 Sec
21,240 Sec
Polling Cycle =
21,600 Secs (6 Hrs)
RADIO OFF
If AUX1=PWRSAVHI, Aux Digital Out 1 = 0V
If AUX1=PWRSAVLO, Aux Digital Out 1 = 5V
Power Saver Example
Polling Cycle = Every 6 Hours (21,600 Sec)
(Dout1 Setting = PwrSavLo or PwrSavHi)
1. Leave Radio ON For 1 Minute (60 Sec) After Receipt of Poll Request.
(OnTime Setting = 60)
2. Then Turn Radio OFF.
3. After 5 Hours, 54 Minutes (21,240 Secs) Has Elapsed, Turn Radio ON.
(OffTime Setting = 21240)
Repeat...

10 AUXILIARY I/O CHANNELS

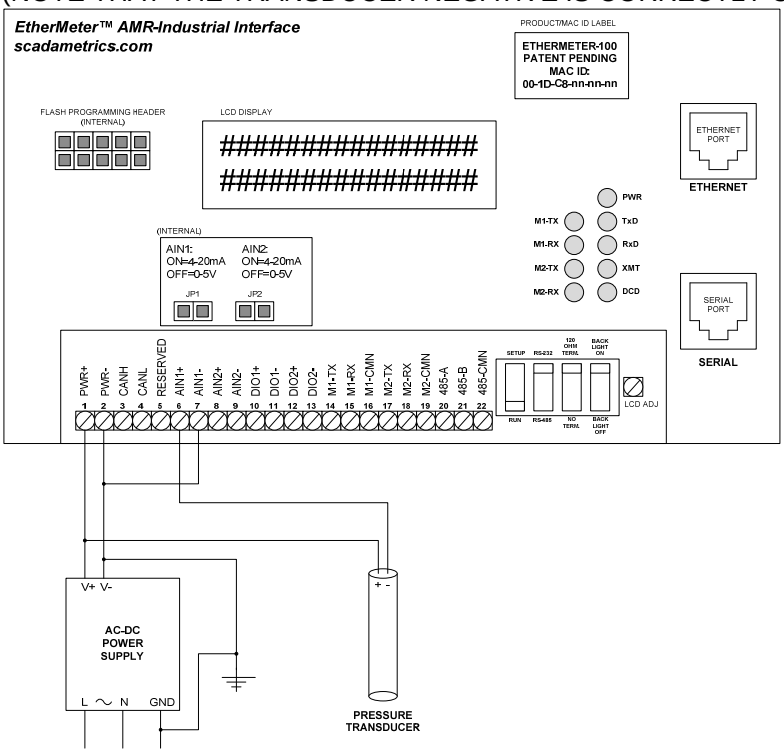
As an added benefit, the EtherMeter is equipped with 4 auxiliary inputs and outputs. These additional I/O make the device suitable for deployment as a standalone RTU at low-complexity locations, such as master meter vaults or even simple pumping stations.

Auxiliary I/O Type	Notes
Digital Input (0 or 1)	Dry Contact Only. Closed = ON (1) Open = OFF (0) Non-Isolated, Fused.
Digital Output(s) (1 or 2)	0-5V TTL Requires an external NRTL-Listed or Recognized Solid-State Relay. eg. Power-IO P/N IO-ODC-60 for DC loads, or Power-IO P/N IO-OAC-280 for AC loads. Digital Output #1 can be used for radio power-saver output. Non-Isolated, Fused.
Analog Input 1	4-20mA (default) or 0-5VDC. 0-5VDC is activated by removing JP1 (inside case). 4-20mA loop resistance = 240 Ohms. AIN1- is connected to DC Common (GND). Caution: AIN1+ should NEVER be connected to a voltage greater than 5VDC above the DC common. (See Recommended Wiring Diagram later in this section.) Non-Isolated, Fused. If isolation is desired, an external analog-to-analog isolation module may be used. (eg. Dataforth Sensorlex® 8B series or DSCA series modules.)

Analog Input 2	4-20mA (default) or 0-5VDC. 0-5VDC is activated by removing JP1 (inside case). 4-20mA loop resistance = 240 Ohms. AIN1- is connected to DC Common (GND). Caution: AIN1+ should NEVER be connected to a voltage greater than 5VDC above the DC common. (See Recommended Wiring Diagram later in this section.) Non-Isolated, Fused. If isolation is desired, an external analog-to-analog isolation module may be used. (eg. Dataforth Sensorlex® 8B series or DSCA series modules.)

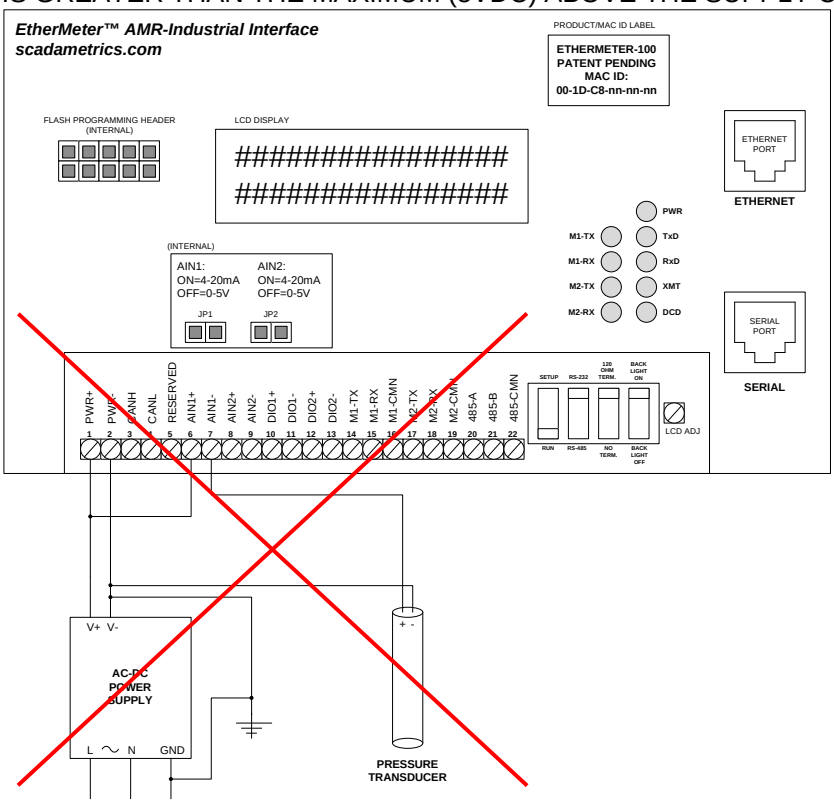
CORRECT ANALOG INPUT WIRING:

(NOTE THAT THE TRANSDUCER NEGATIVE IS CORRECTLY CONNECTED TO AIN1+.)



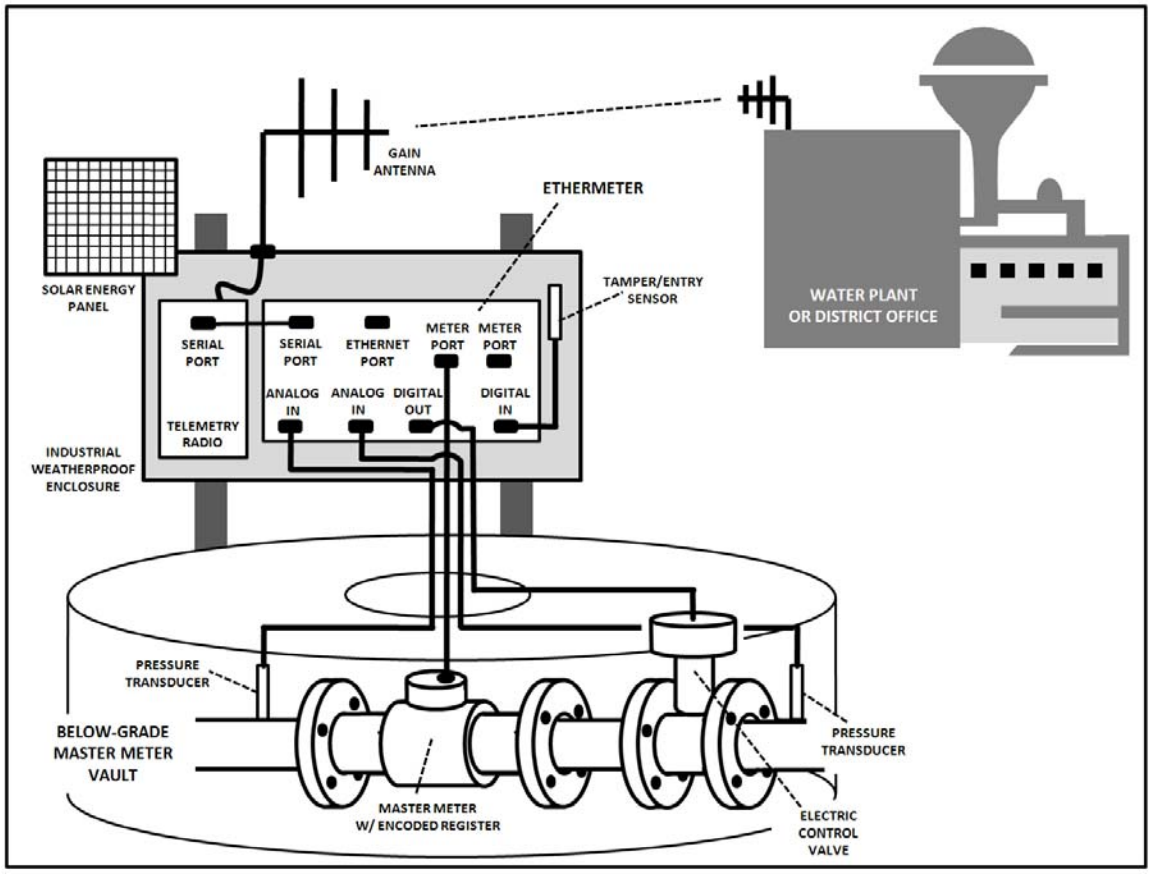
INCORRECT ANALOG INPUT WIRING:

(NOTE THAT THE TRANSDUCER POSITIVE IS INCORRECTLY CONNECTED TO AIN1-.)
(NOTE THAT AIN1+ IS INCORRECTLY CONNECTED TO THE 24VDC SUPPLY, WHICH IS GREATER THAN THE MAXIMUM (5VDC) ABOVE THE SUPPLY COMMON.)



In the previous illustration, wiring is shown for Analog Input Channel #1, although the principles are the same for Analog Input Channel #2.

The following diagram is an example of an EtherMeter deployed as a standalone RTU. Note the use of the auxiliary I/O to provide ON/OFF signaling and analog input monitoring, in addition to monitoring one (or two) meter registers.



11 SETUP AND DIAGNOSTIC UTILITIES

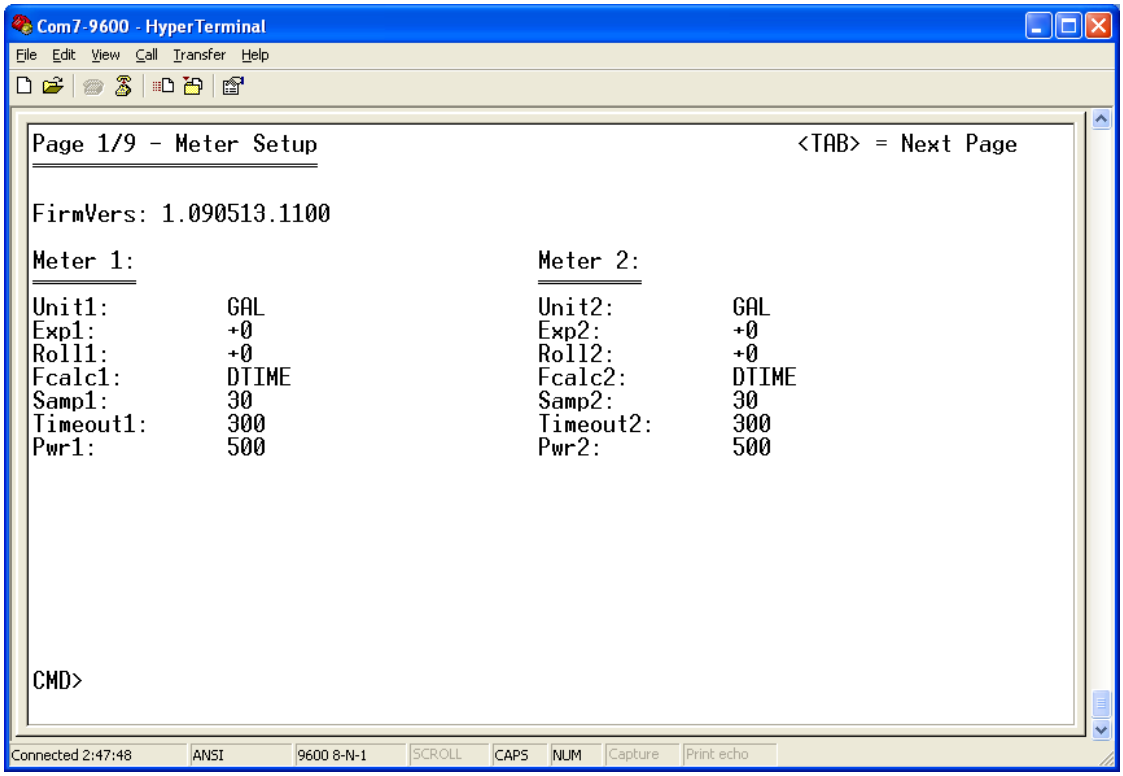
In order to set up the EtherMeter, the technician should actuate the #1 dip switch to the “up” position. At this point, industrial protocols are disabled on the active serial port (RS-232 or RS-485, depending upon the #2 dip switch). In setup mode, the serial port operates with the following parameters:

8 data bits, 1 start bit, 1 stop bit, no parity, no flow control.

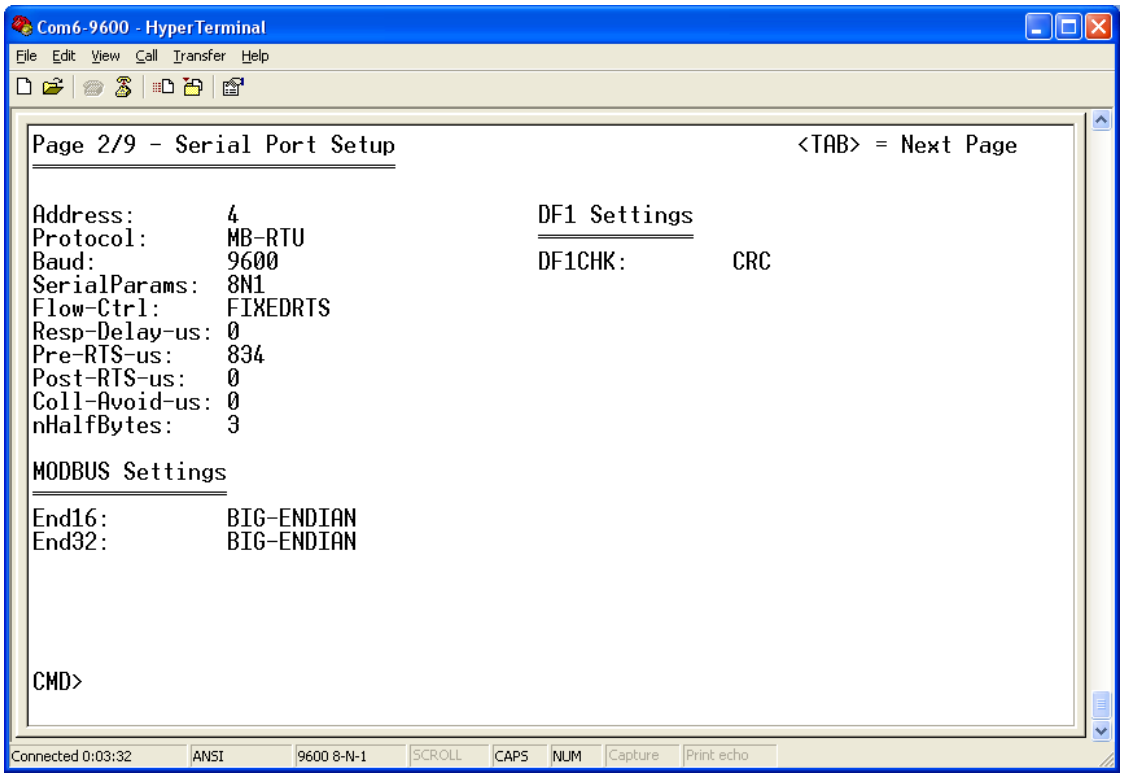
The technician should press the <ENTER> key to refresh the screen.

Note that, from any screen, <ENTER> causes a refresh, and <TAB> causes the display to proceed to the next screen. There are nine (9) setup screens in total.

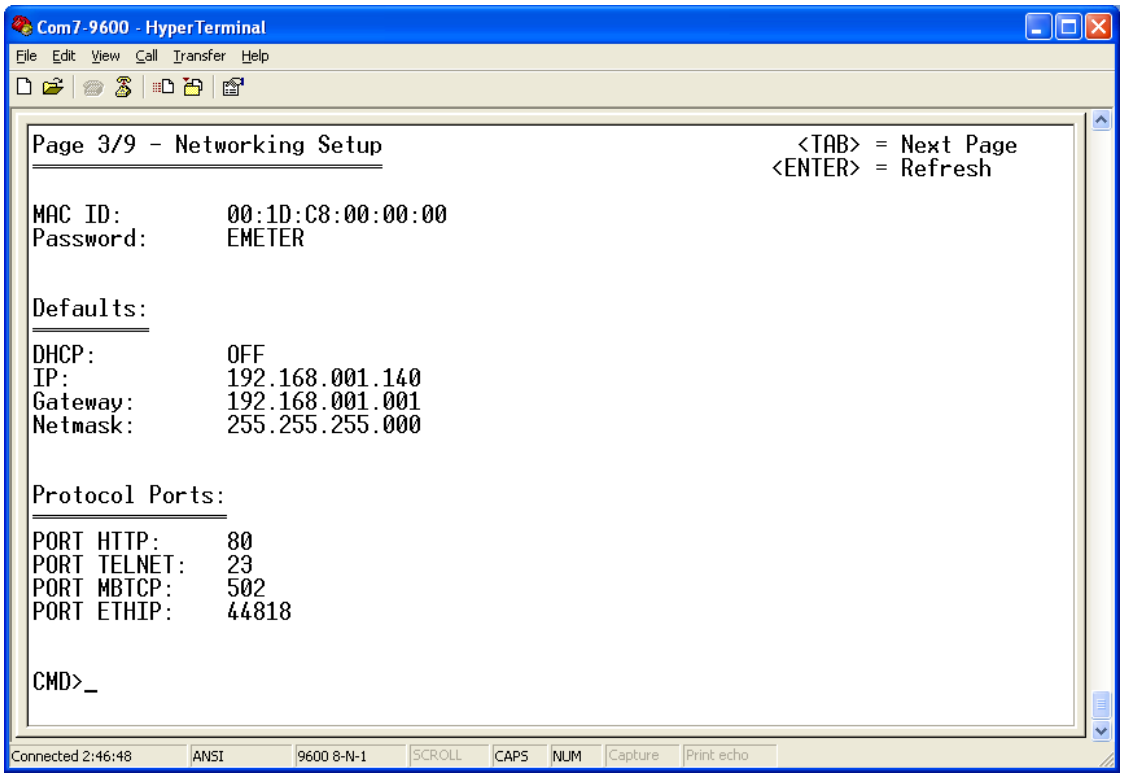
For reference, the nine (9) Setup Menu screens are shown below:



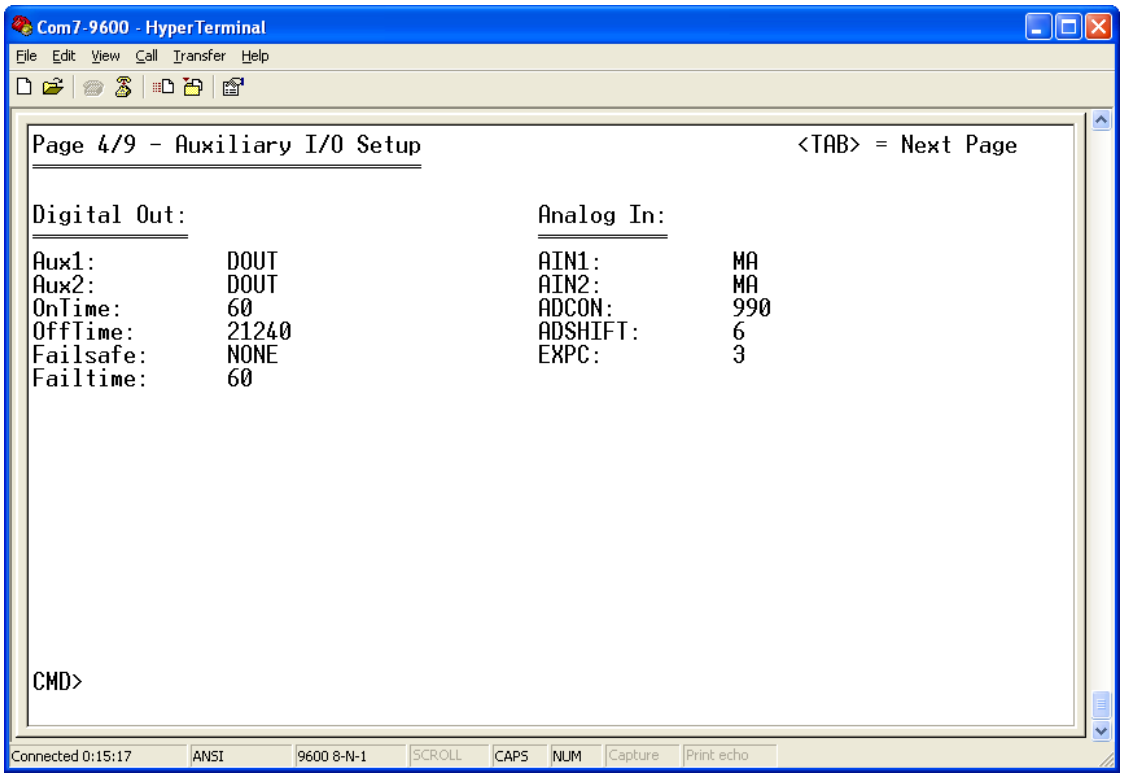
Setup Screen #1 of 9
“Meter Setup”



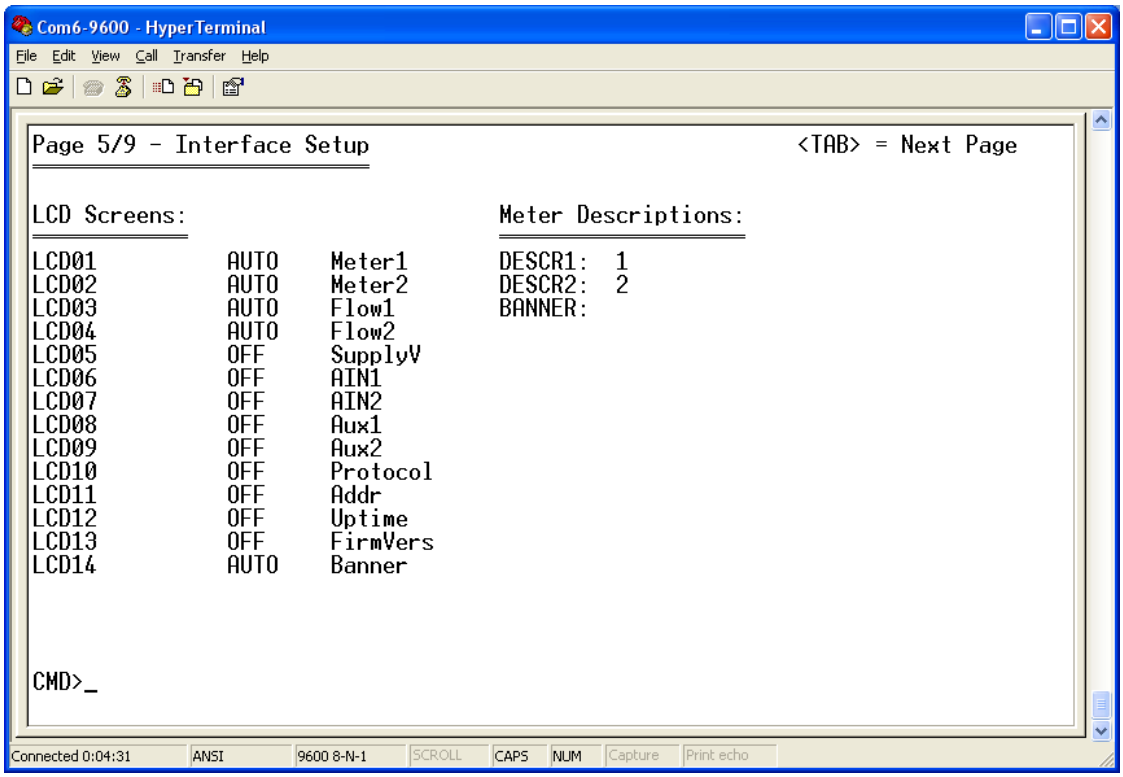
Setup Screen #2 of 9
"Serial Port Setup"



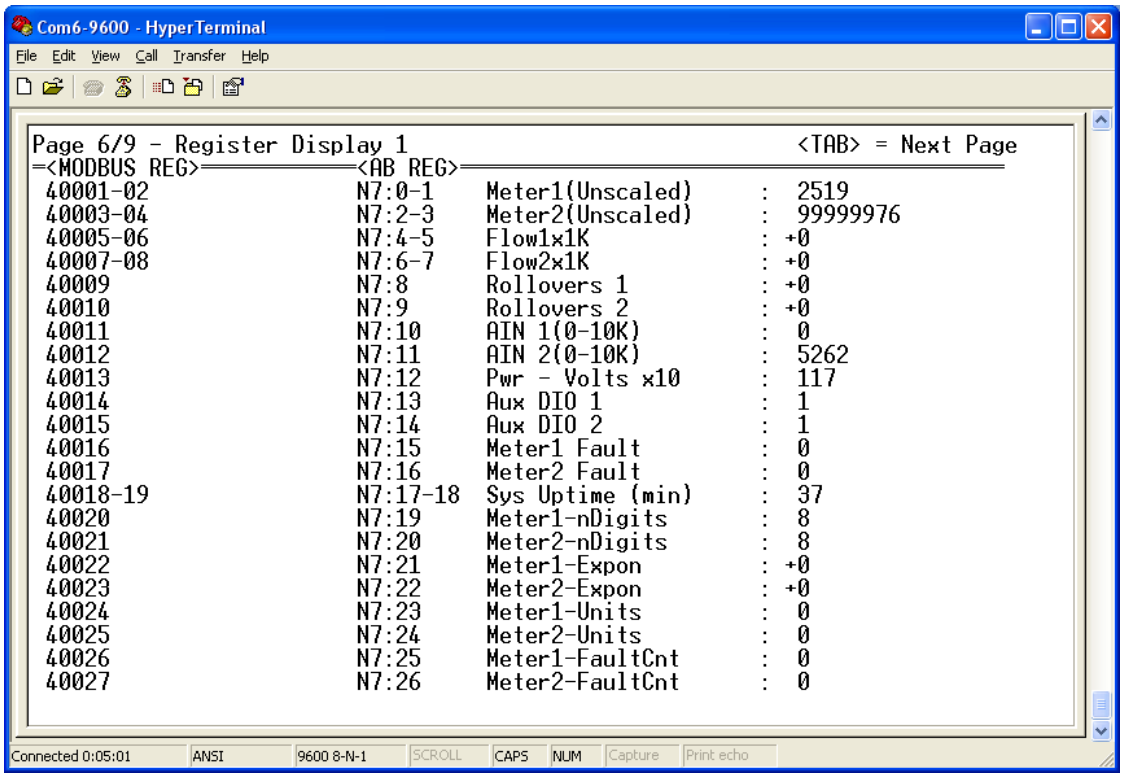
Setup Screen #3 of 9
"Networking Setup"



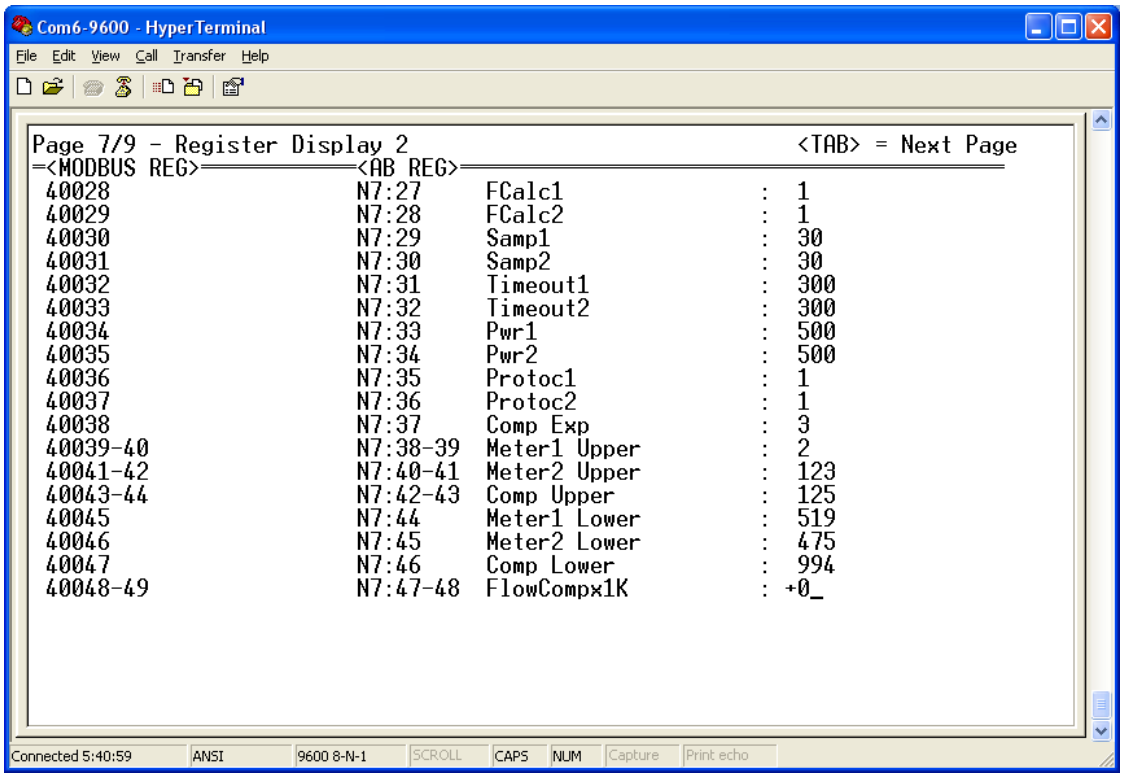
Setup Screen #4 of 9
"Auxiliary I/O Setup"



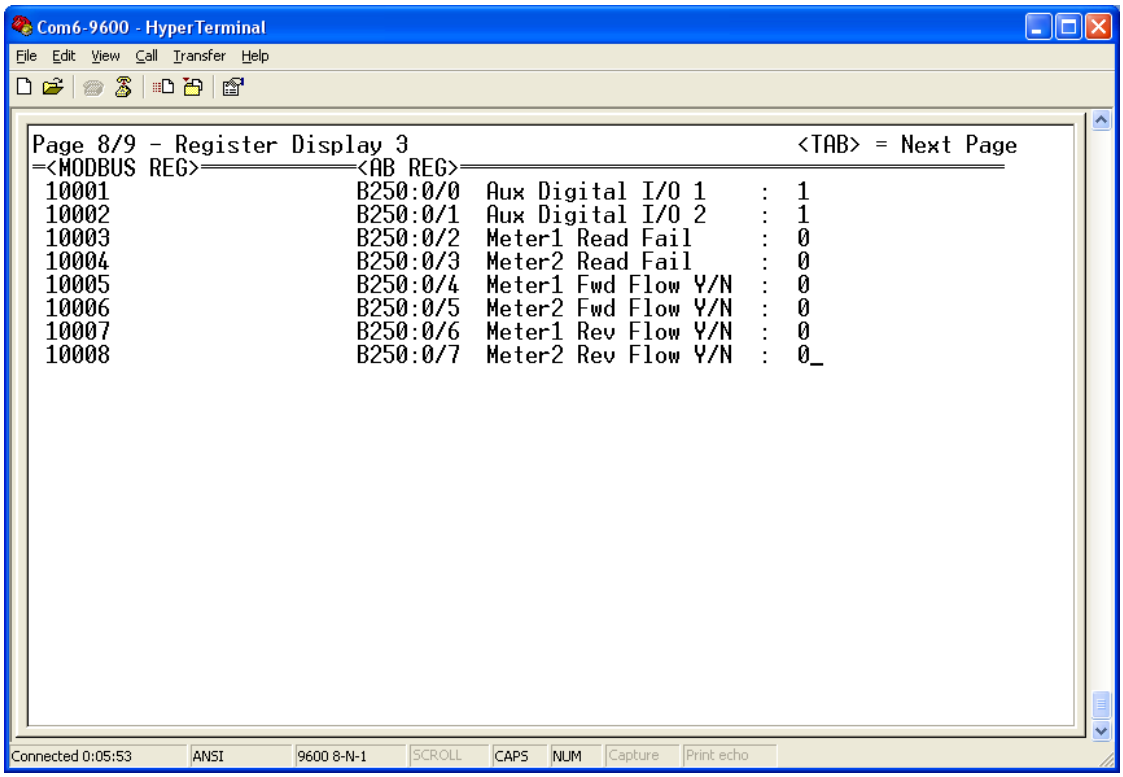
Setup Screen #5 of 9
"Interface Setup"


Com6-9600 - HyperTerminal
File Edit View Call Transfer Help
Page 6/9 - Register Display 1 <TAB> = Next Page
=<MODBUS REG>=<AB REG>
40001-02 N7:0-1 Meter1(Unscaled) : 2519
40003-04 N7:2-3 Meter2(Unscaled) : 99999976
40005-06 N7:4-5 Flow1x1K : +0
40007-08 N7:6-7 Flow2x1K : +0
40009 N7:8 Rollovers 1 : +0
40010 N7:9 Rollovers 2 : +0
40011 N7:10 AIN 1(0-10K) : 0
40012 N7:11 AIN 2(0-10K) : 5262
40013 N7:12 Pwr - Volts x10 : 117
40014 N7:13 Aux DIO 1 : 1
40015 N7:14 Aux DIO 2 : 1
40016 N7:15 Meter1 Fault : 0
40017 N7:16 Meter2 Fault : 0
40018-19 N7:17-18 Sys Uptime (min) : 37
40020 N7:19 Meter1-nDigits : 8
40021 N7:20 Meter2-nDigits : 8
40022 N7:21 Meter1-Expon : +0
40023 N7:22 Meter2-Expon : +0
40024 N7:23 Meter1-Units : 0
40025 N7:24 Meter2-Units : 0
40026 N7:25 Meter1-FaultCnt : 0
40027 N7:26 Meter2-FaultCnt : 0
Connected 0:05:01 ANSI 9600 8-N-1 SCROLL CAPS NUM Capture Print echo

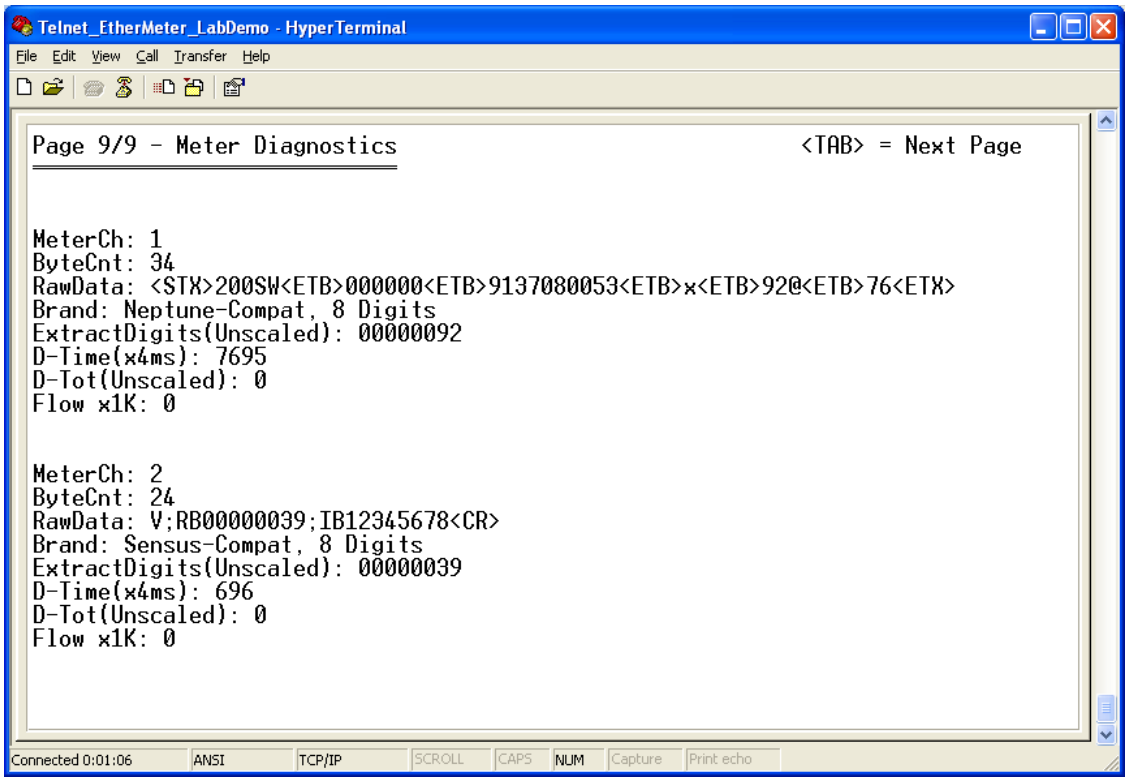
Setup Screen #6 of 9
“MODBUS/DF1 Register Realtime Display 1 of 3”


Com6-9600 - HyperTerminal
File Edit View Call Transfer Help
Page 7/9 - Register Display 2 <TAB> = Next Page
=<MODBUS REG>=<AB REG>
40028 N7:27 FCalc1 : 1
40029 N7:28 FCalc2 : 1
40030 N7:29 Samp1 : 30
40031 N7:30 Samp2 : 30
40032 N7:31 Timeout1 : 300
40033 N7:32 Timeout2 : 300
40034 N7:33 Pwr1 : 500
40035 N7:34 Pwr2 : 500
40036 N7:35 Protoc1 : 1
40037 N7:36 Protoc2 : 1
40038 N7:37 Comp Exp : 3
40039-40 N7:38-39 Meter1 Upper : 2
40041-42 N7:40-41 Meter2 Upper : 123
40043-44 N7:42-43 Comp Upper : 125
40045 N7:44 Meter1 Lower : 519
40046 N7:45 Meter2 Lower : 475
40047 N7:46 Comp Lower : 994
40048-49 N7:47-48 FlowCompx1K : +0_
Connected 5:40:59 ANSI 9600 8-N-1 SCROLL CAPS NUM Capture Print echo

Setup Screen #7 of 9
“MODBUS/DF1 Register Realtime Display 2 of 3”


Com6-9600 - HyperTerminal
File Edit View Call Transfer Help
Page 8/9 - Register Display 3 <TAB> = Next Page
=<MODBUS REG>=========<AB REG>=========
10001 B250:0/0 Aux Digital I/O 1 : 1
10002 B250:0/1 Aux Digital I/O 2 : 1
10003 B250:0/2 Meter1 Read Fail : 0
10004 B250:0/3 Meter2 Read Fail : 0
10005 B250:0/4 Meter1 Fwd Flow Y/N : 0
10006 B250:0/5 Meter2 Fwd Flow Y/N : 0
10007 B250:0/6 Meter1 Rev Flow Y/N : 0
10008 B250:0/7 Meter2 Rev Flow Y/N : 0_
Connected 0:05:53 ANSI 9600 8-N-1 SCROLL CAPS NUM Capture Print echo

Setup Screen #8 of 9
“MODBUS/DF1 Register Realtime Display 3 of 3”



Setup Screen #9 of 9
“Meter Read Diagnostics”

Customizing The EtherMeter™ Through The Setup Menu

Setup commands are entered at the "CMD>" prompt. After each command is entered, it is recommended that the technician verify the modified setting on the Setup Menu Display. For example, to set the run-mode baud rate to 19200, type: SET BAUD 19200 <ENTER>

SETUP MODE COMMANDS:

METER SETUP	SELECTIONS	DEFAULTS
SET UNIT1	GAL, L, FT3, M3 (SELF EXPLANATORY)	GAL
SET UNIT2	GAL, L, FT3, M3	GAL
SET EXP1	-8, -7, -6, -5,-4,-3,-2,-1,0,1,2,3,4,5,6,7,8 SPECIFIES THE PLACEMENT OF THE DECIMAL POINT FOR METER 1. '0' CORRESPONDS TO NOT MOVING THE DECIMAL POINT… '-1' CORRESPONDS TO MOVING THE DECIMAL POINT ONE DIGIT TO THE LEFT… '+1' CORRESPONDS TO MOVING THE DECIMAL POINT ONE DIGIT TO THE RIGHT, ETC… NOTE THAT THIS SETTING SCALES THE TOTAL AND FLOW AS DISPLAYED ON THE 2X16 LCD DISPLAY AND WEB PAGE. HOWEVER, THIS SETTING DOES NOT SCALE THE REPORTED TOTALS IN MODBUS REGISTERS 40001-40004 AND DF1 REGISTERS N7:0-3.	0
SET EXP2	-8, -7, -6, -5,-4,-3,-2,-1,0,1,2,3,4,5,6,7,8	0
SET ROLL1	-100…-5,-4,-3,-2,-1,0,1,2,3,4,5…100 DEVICE WILL COUNT METER ROLLOVERS. USER MAY PRE-LOAD THESE REGISTERS.	0
SET ROLL2	-100…-5,-4,-3,-2,-1,0,1,2,3,4,5…100	0
SET FCALC1	DTIME (Fixed dTime), DTOTAL (Fixed dTotal) SPECIFIES THE FLOW RATE CALCULATION METHOD: DTIME: • FIXED DELTA TIME (EG. 30 SECS) • BEST FOR REGISTER WITH 8 WHEELS • FLOW = DTOTAL / DTIME (FIXED). • FLOW RATE IS RE-CALCULATED AFTER EACH SAMPLE. (SEE SAMP1) DTOTAL: • FIXED DELTA TOTAL (EG. 1000 GAL) • BEST FOR REGISTERS WITH 6 OR FEWER WHEELS • FLOW = DTOTAL (FIXED) / DTIME • FLOW RATE IS RE-CALCULATED WHEN THE REGISTER REPORTS A NEW TOTAL, UNLESS TIMEOUT1 HAS ELAPSED.	DTIME
SET FCALC2	DTIME (Fixed dTime), DTOTAL (Fixed dTotal)	DTIME
SET SAMP1	N (secs) (Meter 1 Sample Period) TIME (SECS) BETWEEN METER READS IF FLOWCALCn=DTIME, SET SAMPn TO 30-180 SECS (TYPICAL). IF FLOWCALCn=DTOTAL, SET SAMPn TO 3-15 SECS (TYPICAL).	30
SET SAMP2	N (secs) (Meter 2 Sample Period)	30
SET TIMEOUT1	N (secs) (Flow Timeout For Fixed dTotal) IF USING FIXED DTOTAL FLOW CALC METHOD, AND METER HAS NOT INCREASED, AND TIMEOUT HAS ELAPSED, DISPLAY AND REPORT FLOW RATE AS ZERO.	240
SET TIMEOUT2	N (secs) (Flow Timeout For Fixed dTotal)	240
SET PWR1	N (msecs) (Time to power on register) INCREASING THIS TIME CAN SOMETIMES HELP OVERCOME HIGH CABLE CAPACITANCE DUE TO LONG METER CABLE RUNS. CAN USE 55 MSEC FOR NEPTUNE E-CODER REGISTERS. FOR ADVANCED USERS ONLY.	500
SET PWR2	N (msecs) (Time to power on register)	500
SET SIMULATION	OFF, ON • ON: ETHERMETER REPORTS METER1 REGISTER AS 12345678, AND FLOW1 REGISTER TO -12345678. USEFUL FOR OFFLINE TESTING. NOTE: SIMULATION MODE IS ALWAYS CLEARED AFTER REBOOT. • OFF: ETHERMETER REPORTS ACTUAL REGISTER CONTENTS. • WHEN SIMULATION=ON, THE SETUP MENU PROMPT IS: **SIMUL>** WHEN SIMULATION=OFF, THE SETUP MENU PROMPT IS: **CMD>**	OFF

SERIAL PORT SETUP	SELECTIONS	DEFAULTS
SET ADDRESS	N (decimal) (Protocol-Specific) DEVICE ADDRESS FOR MODBUS, DF1, AND ADAM-4000 PROTOCOLS. ETHERMETER DOES NOT CHECK ADDRESS FOR RANGE VALIDITY.	4 (decimal)
SET PROTOCOL	MB-RTU, MB-ASCII, DF1-FD, DF1-RM, ASCII, DISPLAY, ADAM (ADAM-VERSION ONLY) (SELF EXPLANATORY)	MB-RTU
SET BAUD	N (bps) NOTE: DEVICE CAPABLE OF NON-STANDARD BAUD RATES.	9600
SET SERIALPARAMS	8N1, 7E1, 7O1, 7N2 8N1 (8 Data Bits, No Parity, 1 Stop Bit) 7E1 (7 Data Bits, Even Parity, 1 Stop Bit) 7O1 (7 Data Bits, Odd Parity, 1 Stop Bit) 7N2 (7 Data Bits, No Parity, 2 Stop Bits)	8N1
SET FLOW-CTRL	FIXEDRTS, NULLMODEM, HANDSHAKE, NONE FIXEDRTS (USE FOR CERTAIN “DUMB” MODEMS & RS-485): • DELAY BEFORE RESPONSE FOR FIXED TIME, • THEN RAISE RTS FOR FIXED TIME, • TRANSMIT DATA • HOLD RTS HIGH FOR FIXED TIME NULL-MODEM: • TRANSMITS IF/WHILE CTS IS HIGH. • LOWERS RTS IF/WHILE RCV BUFFER FULL. HANDSHAKE (USE FOR CERTAIN “SMART” MODEMS): • RAISE RTS WHEN DATA IS READY TO TRANSMIT. • BUT WAIT FOR CTS RCV’D FROM MASTER BEFORE XMT. NONE (USE FOR CERTAIN “SMART” MODEMS): • NO HARDWARE FLOW CONTROL • ACTIVE WIRES: TXD, RXD, AND GND NOTE: SOFTWARE FLOW CONTROL IS NOT SUPPORTED.	FIXEDRTS
SET RESP-DELAY-US	N (usecs) • USED WITH “FIXEDRTS” FLOW CONTROL ONLY. • TIME DELAY BEFORE RESPONDING TO A REQUEST BY A MASTER. • USEFUL FOR TUNING RS-485 OR RADIO-MODEM TIMING. • IMPLEMENTED IN MULTIPLES OF 834 MICROSECONDS.	0
SET PRE-RTS-US	N (usecs) • USED WITH “FIXEDRTS” FLOW CONTROL ONLY. • AFTER RESP-DELAY-US, THIS IS THE TIME DELAY WHILE HOLDING RTS HIGH. • USEFUL FOR TUNING RS-485 OR RADIO-MODEM TIMING. • IMPLEMENTED IN MULTIPLES OF 834 MICROSECONDS.	834
SET POST-RTS-US	N (usecs) • USED WITH “FIXEDRTS” FLOW CONTROL ONLY. • AFTER DATA IS COMPLETELY TRANSMITTED, THIS IS THE TIME DELAY FOR HOLDING RTS HIGH. • USEFUL FOR TUNING RS-485 OR RADIO-MODEM TIMING. • IMPLEMENTED IN MULTIPLES OF 834 MICROSECONDS.	0
SET COLL-AVOID-US	N (usecs) • USED WITH “FIXEDRTS” FLOW CONTROL ONLY. • IF NON-ZERO, TRANSMITTER WILL WAIT UP TO N MICROSECONDS FOR DCD TO GO LOW BEFORE TRANSMITTING. • USEFUL FOR IMPLEMENTING COLLISION-AVOIDANCE WITH “DUMB” RADIO-MODEMS. • IMPLEMENTED IN MULTIPLES OF 834 MICROSECONDS.	0
SET NHALFBYTES	N (halfbytes) • MODIFIES MODBUS/RTU AND DF1 SERIAL RECEPTION BEHAVIOR. DURING DATA PACKET RECEPTION, AFTER “N” HALF-BYTE TIME PERIODS HAVE ELAPSED WITH NO FURTHER DATA RECEIVED, THEN END-OF-PACKET IS ASSUMED. DOES NOT AFFECT MODBUS/ASCII OR ADAM-4000 RECEPTION BEHAVIOR. • MODIFYING THIS SETTING MAY IMPROVE RECEPTION RELIABILITY WHEN USING AN UNCONDITIONED (EG. BELL-202) RADIO-MODEM.	7 (MODBUS/RTU DEFAULT = 3.5 BYTE TIMES)

MODBUS SETUP	SELECTIONS	DEFAULTS
SET END16	BIG-ENDIAN, LITTLE-ENDIAN • BIG-ENDIAN – MS (MOST SIGNIFICANT) BYTE TRANSMITTED FIRST • LITTLE-ENDIAN – LS (LEAST SIGNIFICANT) BYTE TRANSMITTED FIRST	BIG-ENDIAN
SET END32	BIG-ENDIAN, LITTLE-ENDIAN • BIG-ENDIAN – MS (MOST SIGNIFICANT) WORD TRANSMITTED FIRST • LITTLE-ENDIAN – LS (LEAST SIGNIFICANT) WORD TRANSMITTED FIRST	BIG-ENDIAN
DF1 SETUP	**SELECTIONS**	**DEFAULTS**
SET DF1CHK	CRC, BCC • CRC (DEFAULT) – USE 16-BIT CRC ERROR CHECKING • BCC – USE 8-BIT CHECKSUM	CRC
ADAM-4000 SETUP	**SELECTIONS**	**DEFAULTS**
SET ADMCHK (ADAM-VERSION ONLY)	OFF, ON • OFF (ADAM-4000 DEFAULT) – TURN OFF CHECKSUM ERROR CHECKING • ON – TURN ON CHECKSUM ERROR CHECKING	OFF
NETWORK SETUP	**SELECTIONS**	**DEFAULTS**
SET DHCP	OFF, ON • OFF (DEFAULT) – USE DEFAULT IP ADDRESS, GATEWAY ADDRESS, AND NETMASK. • ON – USE DHCP TO FETCH IP ADDRESS, GATEWAY ADDRESS, AND NETMASK.	OFF
SET IP	nnn.nnn.nnn.nnn • DEFAULT IP ADDRESS • IGNORED WHEN DHCP IS ON	192.168.1.140
SET GATEWAY	nnn.nnn.nnn.nnn • DEFAULT GATEWAY ADDRESS • IGNORED WHEN DHCP IS ON	192.168.1.1
SET NETMASK	nnn.nnn.nnn.nnn • DEFAULT NETMASK • IGNORED WHEN DHCP IS ON	255.255.255.0
SET PASSWORD	AAAAAAAA • TELNET PASSWORD (CASE INSENSITIVE, 8 CHARS MAX) • TELNET USERNAME IS FIXED AS: EMETER	EMETER
SET PORT HTTP	1 – 65535 TCP PORT FOR WEB SERVER	80
SET PORT TELNET	1 – 65535 TCP PORT FOR TELNET SERVER	23
SET PORT MBTCP	1 – 65535 TCP PORT FOR MODBUS/TCP, UDP PORT FOR MODBUS/UDP	502
SET PORT ETHIP	1 – 65535 TCP PORT FOR ETHERNET/IP	44818

AUX I/O SETUP	SELECTIONS	DEFAULTS
SET AUX1	DOUT, PWRSAVHI, PWRSAVLO DOUT: • DIGITAL OUTPUT – FOLLOWS COMMANDS FROM MODBUS OR DF1 (OR ADAM) MASTER PWRSAVHI: • DIGITAL OUTPUT GOES “HI” (5V) TO TURN ON CONNECTED RADIO OR MODEM. PWRSAVLO: • DIGITAL OUTPUT GOES “LO” (0V) TO TURN ON CONNECTED RADIO OR MODEM. (FOR PWRSAVLO AND PWRSAVHI TIMING DIAGRAMS, SEE SECTION 9, RADIO INTERFACE.)	DOUT
SET AUX2	DOUT, DIN DOUT: • DIGITAL OUTPUT – FOLLOWS COMMANDS FROM MODBUS, DF1, ETHERNET/IP, OR ADAM MASTER DIN: • DIGITAL INPUT – MAY BE MONITORED BY INTERROGATION FROM MODBUS, DF1, ETHERNET/IP, OR ADAM MASTER	DOUT
SET ONTIME	N (secs) • USED WHEN DOUT1=PWRSAVHI OR PWRSAVLO • TIME TO LEAVE RADIO ON AFTER THE RECEIPT OF A POLL REQUEST ADDRESSED TO THIS DEVICE. • FOR TIMING DIAGRAM, SEE SECTION 9, RADIO INTERFACE.	60 (1 min)
SET OFFTIME	N (secs) • AFTER RECEIPT OF POLL REQUEST AND AFTER ONTIME ELAPSED, TIME TO LEAVE RADIO OFF. • AFTER OFFTIME ELAPSES, RADIO WILL BE TURNED OFF AND DEVICE WILL WAIT FOR NEXT POLL REQUEST. • FOR TIMING DIAGRAM, SEE SECTION 9, RADIO INTERFACE.	21240 (5 hrs,54min)
SET FAILSAFE	NONE, ON, OFF ON: • WHEN POLL NOT RECEIVED FOR FAILTIME (SECS), TURN DIGITAL OUTPUT(S) ON. OFF: • WHEN POLL NOT RECEIVED FOR FAILTIME (SECS), TURN DIGITAL OUTPUT(S) OFF. NONE: • IGNORE FAILTIME. (‘FAILSAFE’ SETTING ONLY AFFECTS DIGITAL OUTPUT 1 WHEN DOUT1=AUTO.)	NONE
SET FAILTIME	N (secs) WHEN POLL NOT RECEIVED AFTER FAILTIME (SECS) HAS ELAPSED, DIGITAL OUTPUT(S) PUT INTO FAILSAFE STATE (‘FAILSAFE’ SETTING ONLY AFFECTS DIGITAL OUTPUT 1 WHEN DOUT1=AUTO.)	60
SET AIN1	MA, V MA: 0 (0%) ➔ 4 MA 10000 (100%) ➔ 20 MA V: 0 (0%) ➔ 0 V 10000 (100%) ➔ 5 V (NOTE: FOR 0-5V INPUT, REMOVE JP1)	MA

SET AIN2	MA, V MA: 0 (0%) ➔ 4 MA 10000 (100%) ➔ 20 MA V: 0 (0%) ➔ 0 V 10000 (100%) ➔ 5 V (NOTE: FOR 0-5V INPUT, REMOVE JP2)	MA
SET ADCONST	A/D CONVERTER CONSTANT 1 - FACTORY USE ONLY	1000
SET ADSHIFT	0, 1, 2, 3, 4, 5, 6 A/D CONVERTER CONSTANT 2 - FACTORY USE ONLY	6
SET EXPC	0, 1, 2, 3, 4 SPECIFIES THE EXPONENTIAL MULTIPLIER FOR THE REGISTERS CONTAINING THE COMPOUND METER TOTAL AND METER 1 AND 2 SCALED TOTALS. USE CAUTION WHEN MODIFYING THIS PARAMETER. INTEGER OVERFLOW IS POSSIBLE IF AN ILL-CHOSEN PARAMETER IS USED.	3
AUX I/O SETUP	**SELECTIONS**	**DEFAULTS**
SET LCD01	AUTO, ON, OFF CONTROLS LCD DISPLAY OF METER #1 TOTALIZATION. AUTO: DISPLAY ACTIVE WHEN METER #1 DETECTED. ON: DISPLAY ACTIVE, REGARDLESS OF WHETHER METER 1 DETECTED. OFF: SUPPRESSES DISPLAY. NOTE: FOR CONVENIENCE, ALL LCD SCREENS ARE SEQUENTIALLY DISPLAYED RIGHT AFTER POWERUP AND RIGHT AFTER SWITCHING FROM SETUP MODE TO RUN MODE (DIP SWITCH #1).	AUTO
SET LCD02	AUTO, ON, OFF CONTROLS LCD DISPLAY OF METER #2 TOTALIZATION. AUTO: DISPLAY ACTIVE WHEN METER #2 DETECTED. ON: DISPLAY ACTIVE, REGARDLESS OF WHETHER METER #2 DETECTED. OFF: SUPPRESSES DISPLAY.	AUTO
SET LCD03	AUTO, ON, OFF CONTROLS LCD DISPLAY OF METER #1 FLOW RATE. AUTO: DISPLAY ACTIVE WHEN METER #1 DETECTED. ON: DISPLAY ACTIVE, REGARDLESS OF WHETHER METER #1 DETECTED. OFF: SUPPRESSES DISPLAY.	AUTO
SET LCD04	AUTO, ON, OFF CONTROLS LCD DISPLAY OF METER #2 FLOW RATE. AUTO: DISPLAY ACTIVE WHEN METER #2 DETECTED. ON: DISPLAY ACTIVE, REGARDLESS OF WHETHER METER #2 DETECTED. OFF: SUPPRESSES DISPLAY.	AUTO

SET LCD05	ON, OFF CONTROLS LCD DISPLAY OF POWER SUPPLY VOLTAGE. ON: DISPLAY ACTIVE. OFF: SUPPRESSES DISPLAY.	OFF
SET LCD06	ON, OFF CONTROLS LCD DISPLAY OF ANALOG INPUT #1. ON: DISPLAY ACTIVE. OFF: SUPPRESSES DISPLAY.	OFF
SET LCD07	ON, OFF CONTROLS LCD DISPLAY OF ANALOG INPUT #2. ON: DISPLAY ACTIVE. OFF: SUPPRESSES DISPLAY.	OFF
SET LCD08	ON, OFF CONTROLS LCD DISPLAY OF AUX DIGITAL I/O #1. ON: DISPLAY ACTIVE. OFF: SUPPRESSES DISPLAY.	OFF
SET LCD09	ON, OFF CONTROLS LCD DISPLAY OF AUX DIGITAL I/O #2. ON: DISPLAY ACTIVE. OFF: SUPPRESSES DISPLAY.	OFF
SET LCD10	ON, OFF CONTROLS LCD DISPLAY OF ACTIVE SERIAL PROTOCOL. ON: DISPLAY ACTIVE. OFF: SUPPRESSES DISPLAY.	OFF
SET LCD11	ON, OFF CONTROLS LCD DISPLAY OF DEVICE (SERIAL) ADDRESS. ON: DISPLAY ACTIVE. OFF: SUPPRESSES DISPLAY.	OFF
SET LCD12	ON, OFF CONTROLS LCD DISPLAY OF DEVICE UPTIME (MINUTES). ON: DISPLAY ACTIVE. OFF: SUPPRESSES DISPLAY.	OFF
SET LCD13	ON, OFF CONTROLS LCD DISPLAY OF FIRMWARE VERSION. ON: DISPLAY ACTIVE. OFF: SUPPRESSES DISPLAY.	OFF

SET LCD14	AUTO, ON, OFF CONTROLS LCD DISPLAY OF BANNER TEXT. AUTO: DISPLAYS WHEN BANNER TEXT EXISTS (WHEN BANNER TEXT HAS BEEN ENTERED BY THE USER). ON: DISPLAY ACTIVE. OFF: SUPPRESSES DISPLAY.	AUTO
SET DESCR1	TEXT DESCRIPTION FOR THE METER ATTACHED TO CHANNEL 1 (1 TO 4 CHARACTERS, NO SPACES).	1
SET DESCR2	TEXT DESCRIPTION FOR THE METER ATTACHED TO CHANNEL 2 (1 TO 4 CHARACTERS, NO SPACES).	2
SET BANNER	TEXT DESCRIPTION FOR THE ETHERMETER'S LOCATION/PURPOSE/ETC... (1 TO 32 CHARACTERS). NOTE 1: THE BANNER TEXT ENTERED SHOULD NOT CONTAIN ANY SPACES. UNDERSCORES SHOULD BE ENTERED IN LIEU OF SPACES WHEREVER NEEDED. THE ETHERMETER WILL AUTOMATICALLY REPLACE THE UNDERSCORES WITH SPACES ON THE LCD DISPLAY, WEB PAGE, AND SETUP MENU. NOTE 2: TO CLEAR THE BANNER TEXT, TYPE: "SET BANNER<ENTER>"	<BLANK>

NOTE 1: THE UNIT EXECUTES A SOFT RESTART WHEN "REBOOT" IS ENTERED AT THE COMMAND PROMPT.

NOTE 2: THE FACTORY DEFAULT SETTINGS ARE RESTORED WHEN "FACTORYRESET" IS ENTERED AT THE COMMAND PROMPT.

12 MODBUS® PROTOCOL SUPPORT

This manual assumes that the user is well-versed in the MODBUS Protocol. In order to learn more about the MODBUS protocol, visit modicon.com or modbus.org.

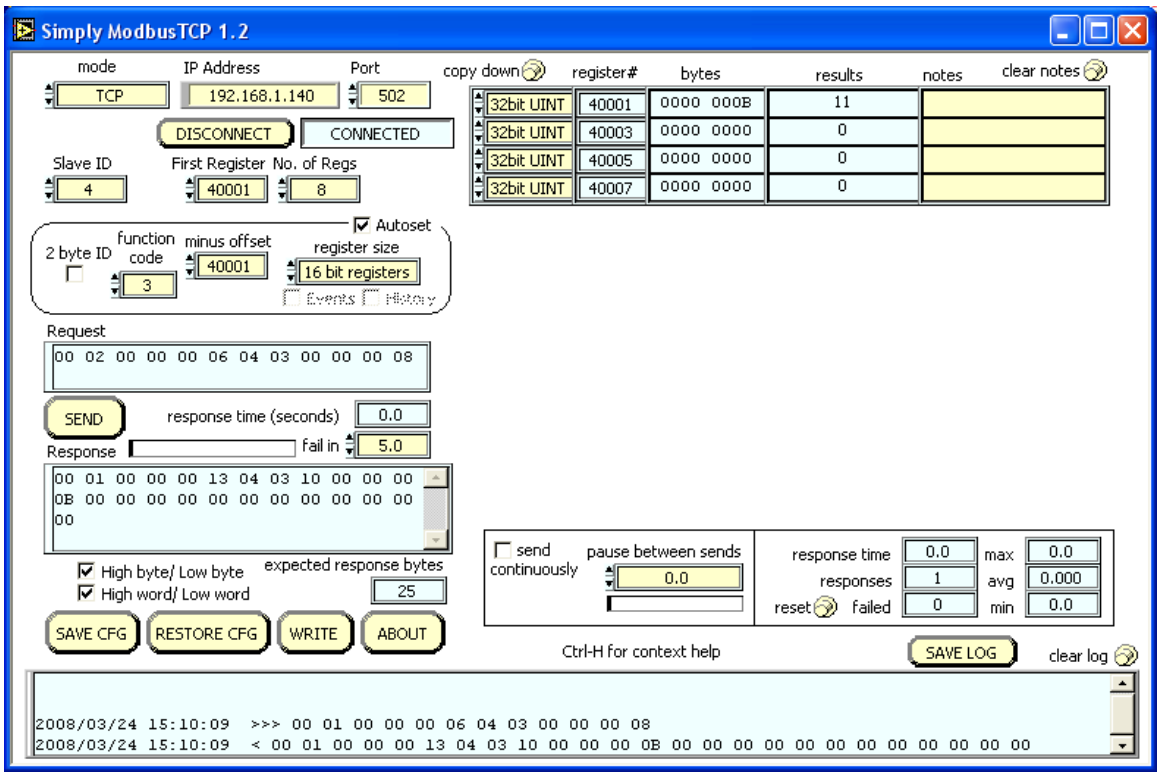
The following subset of the MODBUS protocol is supported by the EtherMeter:

01 - Read Coil Status
02 - Read Input Status
03 - Read Holding Registers
04 - Read Input Registers (Mirrors Function 03)
05 - Force Single Coil
15 - Force Multiple Coils

The default byte-order is “high-byte / low-byte” and the default word order is “high-word / low-word”. This method of ordering is also known as “Big-Endian”. However, the MODBUS byte-order and word-order can be modified through the Setup Menu.

In keeping with MODBUS/TCP protocol specifications, The EtherMeter ignores the “Device Address” field that is transmitted within all MODBUS/TCP/UDP requests, as the EtherMeter is sufficiently distinguished by its IP address. Please note that fragmented MODBUS/TCP/UDP packets are not supported.

To test and/or verify MODBUS communications with the EtherMeter, there are several useful computer programs available. SCADAmetrics recommends the SimplyModbusRTU and SimplyModbusTCP programs, which are available for a modest price from www.simplymodbus.ca. Assistance and support for these programs (and all 3rd-party software) may be obtained from their respective manufacturers.



A Screen Snapshot of the Simply Modbus TCP Client.

FUNCTION: 03(READ)

REGISTERS	DESCRIPTORS
40001,40002*	METER 1 TOTAL (UNSCALED)
40003,40004*	METER 2 TOTAL (UNSCALED)
40005,40006**	FLOW 1 X 1000
40007,40008**	FLOW 2 X 1000
40009	ROLLOVERS – METER 1
40010	ROLLOVERS – METER 2
40011	AIN 1 (0-10000)
40012	AIN 2 (0-10000)
40013	SUPPLY VOLTS X 10
40014	AUXILIARY DIGITAL I/O 1
40015	AUXILIARY DIGITAL I/O 2
40016	METER 1 READ FAULT
40017	METER 2 READ FAULT
40018,40019*	SYSTEM UPTIME (MINUTES)
40020	METER 1 nDIGITS
40021	METER 2 nDIGITS
40022	METER 1 EXPONENT
40023	METER 2 EXPONENT
40024	METER 1 UNITS
40025	METER 2 UNITS
40026	METER 1 READ FAULT COUNTER
40027	METER 2 READ FAULT COUNTER
40028	METER 1 FLOW CALC METHOD
40029	METER 2 FLOW CALC METHOD
40030	METER 1 SAMPLE PERIOD (SECS)
40031	METER 2 SAMPLE PERIOD (SECS)
40032	METER 1 FLOW TIMEOUT (SECS)
40033	METER 2 FLOW TIMEOUT (SECS)
40034	METER 1 POWERUP (MSECS)
40035	METER 2 POWERUP (MSECS)
40036	METER 1 PROTOCOL (1=SENSUS,2=NEPTUNE)
40037	METER 2 PROTOCOL (1=SENSUS,2=NEPTUNE)
40038	COMPOUNDED METER EXPONENT (COMP EXP)
40039,40040*	METER 1 UPPER TOTAL (ACTUAL / $10^{(COMP\ EXP)}$)
40041,40042*	METER 2 UPPER TOTAL (ACTUAL / $10^{(COMP\ EXP)}$)
40043,40044*	COMPOUND METER UPPER TOTAL (ACTUAL / $10^{(COMP\ EXP)}$)
40045	METER 1 LOWER TOTAL (ACTUAL % $10^{(COMP\ EXP)}$)
40046	METER 2 LOWER TOTAL (ACTUAL % $10^{(COMP\ EXP)}$)
40047	COMPOUND METER LOWER TOTAL (ACTUAL % $10^{(COMP\ EXP)}$)
40048,40049**	COMPOUND FLOW X 1000

*DATA OCCUPYING THESE REGISTERS ARE 32-BIT UNSIGNED LONG INTEGERS.
**DATA OCCUPYING THESE REGISTERS ARE 32-BIT SIGNED LONG INTEGERS.
ALL OTHERS ARE 16-BIT SIGNED INTEGERS

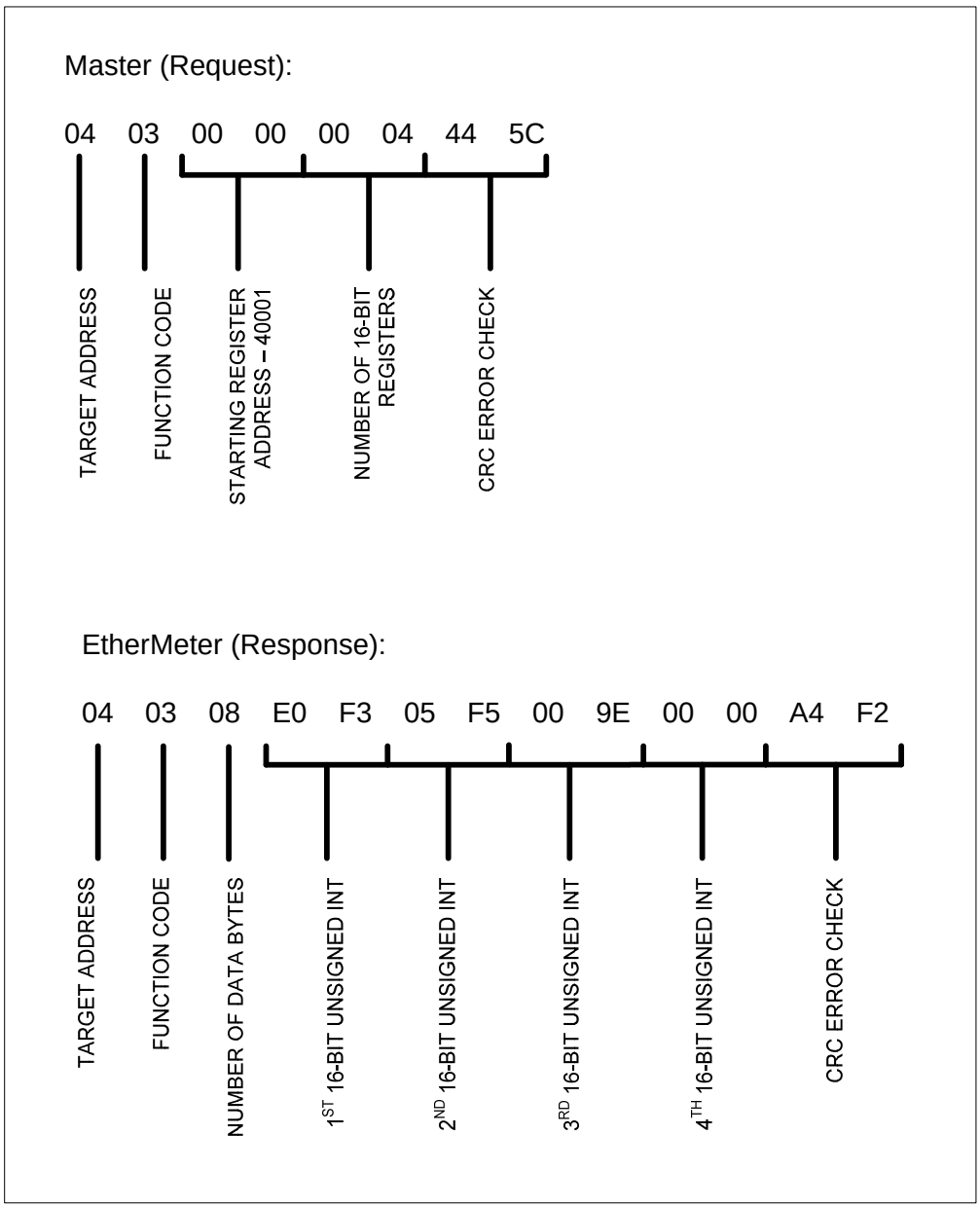
FUNCTION: 02(READ)

INPUTS	DESCRIPTORS
10001	AUXILIARY DIGITAL I/O 1
10002	AUXILIARY DIGITAL I/O 2
10003	METER 1 READ FAULT
10004	METER 2 READ FAULT
10005	METER 1 FORWARD FLOW (Y/N)
10006	METER 2 FORWARD FLOW (Y/N)
10007	METER 1 REVERSE FLOW (Y/N)
10008	METER 2 REVERSE FLOW (Y/N)

FUNCTION: 01(READ) / 05(WRITE) / 15(WRITE)

COILS	DESCRIPTOR
00001	AUXILIARY DIGITAL OUTPUT 1
00002	AUXILIARY DIGITAL OUTPUT 2

EtherMeter MODBUS Register Map.


Master (Request):
04 03 00 00 00 04 44 5C
TARGET ADDRESS
FUNCTION CODE
STARTING REGISTER ADDRESS – 40001
NUMBER OF 16-BIT REGISTERS
CRC ERROR CHECK
EtherMeter (Response):
04 03 08 E0 F3 05 F5 00 9E 00 00 A4 F2
TARGET ADDRESS
FUNCTION CODE
NUMBER OF DATA BYTES
1ST 16-BIT UNSIGNED INT
2ND 16-BIT UNSIGNED INT
3RD 16-BIT UNSIGNED INT
4TH 16-BIT UNSIGNED INT
CRC ERROR CHECK

Example MODBUS Request/Response.

Sample MODBUS/RTU Commands:

The following samples are provided to familiarize the user with a few of the core EtherMeter MODBUS/RTU commands. In all samples, the device address=4. Note that the users' responses will vary in accordance with the unique I/O state of each EtherMeter.

Read: Meter 1, Meter 2, Flow 1, Flow 2
MODBUS Function 3

Request: **04 03 00 00 00 08 44 59**
Response (example): **04 03 10 00 00 00 2F 00 00 02 0C 00 00 00 00 00 00 00 00 B7 30**

Read: All Eight (8) Digital Inputs
MODBUS Function 2

Request: **04 02 00 00 00 08 79 99**
Response (example): **04 02 01 03 E1 45**

Write: Turn 1st Coil ON (Aux Digital I/O 1)
MODBUS Function 5

Request: **04 05 00 00 FF 00 8C 6F**
Response (example): **04 05 00 00 FF 00 8C 6F**

Write: Turn 1st Coil OFF (Aux Digital I/O 1)
MODBUS Function 5

Request: **04 05 00 00 00 00 CD 9F**
Response (example): **04 05 00 00 00 00 CD 9F**

Write: Turn 2nd Coil ON (Aux Digital I/O 2)
MODBUS Function 5

Request: **04 05 00 01 FF 00 DD AF**
Response (example): **04 05 00 01 FF 00 DD AF**

Write: Turn 2nd Coil OFF (Aux Digital I/O 2)
MODBUS Function 5

Request: **04 05 00 01 00 00 9C 5F**
Response (example): **04 05 00 01 00 00 9C 5F**

TOTALIZATION AND FLOW DATA FORMAT:

The EtherMeter was designed in such a way as to simplify and compress the formatting of all reported data. As shown in the previous charts, no floating point or 64-bit registers are implemented in the holding (4xxxx) registers, as all data is represented internally as 32-bit long integers (signed or unsigned) and 16-bit signed integers.

In order to achieve a high level of simplicity and prevent integer overflows, separate exponential scale factors and multipliers are provided in certain MODBUS registers.

If fully-scaled totalization data is desired, then 64-bit data processing may be required by the MODBUS master polling PLC or computer. In most instances, however, 32-bit data manipulation will suffice.

TOTALIZATION HELPER FORMULAS:

The following calculations are examples helper formulas that may be implemented within the master. When deciding whether to use 64-bit versus 32-bit data manipulation routines at the master, it is recommended that the user factor in the largest expected meter totalization value (meter-specific), and consider that the largest possible 32-bit unsigned long integer is 4,294,967,295.

Meter 1 Actual Total = [METER 1 UPPER TOTAL] x $[10^{[\text{COMP EXP}]}]$ + [METER 1 LOWER TOTAL]
= [40039,40040] x $[10^{[40038]}]$ + [40045]

Meter 2 Actual Total = [METER 2 UPPER TOTAL] x $[10^{[\text{COMP EXP}]}]$ + [METER 2 LOWER TOTAL]
= [40041,40042] x $[10^{[40038]}]$ + [40046]

Comp. Actual Total = [COMP. UPPER TOTAL] x $[10^{[\text{COMP EXP}]}]$ + [COMP. LOWER TOTAL]
= [40043,40044] x $[10^{[40038]}]$ + [40047]

Alternatively:

Meter 1 Actual Total = [METER 1 TOTAL UNSCALED] x $[10^{[\text{METER 1 EXPONENT}]}]$
+ [ROLLOVERS METER 1] x $[10^{[\text{METER 1 nDIGITS}]}]$ x $[10^{[\text{METER 1 EXPONENT}]}]$
= [40001,40002] x $[10^{[40022]}]$ + [40009] x $[10^{[40020]}]$ x $[10^{[40022]}]$

Meter 2 Actual Total = [METER 2 TOTAL UNSCALED] x $[10^{[\text{METER 2 EXPONENT}]}]$
+ [ROLLOVERS METER 2] x $[10^{[\text{METER 2 nDIGITS}]}]$ x $[10^{[\text{METER 2 EXPONENT}]}]$
= [40003,40004] x $[10^{[40023]}]$ + [40010] x $[10^{[40021]}]$ x $[10^{[40023]}]$

FLOW RATE HELPER FORMULAS:

The following are possible flow rate helper formulas that may be implemented within a MODBUS master polling PLC or computer:

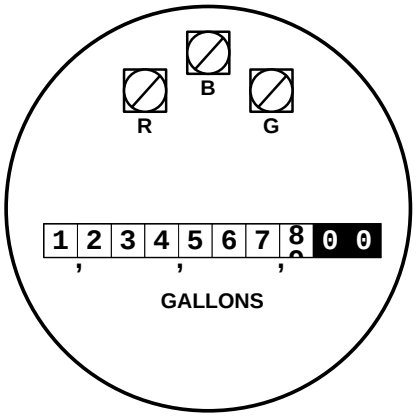
Meter 1 Actual Flow = [FLOW 1] / 1000
= [40005,40006] / 1000

Meter 2 Actual Flow = [FLOW 2] / 1000
= [40007,40008] / 1000

Comp. Actual Flow = [COMP. FLOW] / 1000
= [40048,40049] / 1000

EXAMPLE:

Consider the following case of a meter register installed on meter channel 1. This register contains 8 variable digits plus two (2) fixed zeros on the right. (EXP1=+2.)



In this case, the actual total is 1,234,567,800 gallons. However, the [40001,40002] MODBUS holding register will report the total as: 12,345,678. If scaling to GALLONS is desired, then the polling device (master) must perform the scaling (multiply by $10^{(EXPn)}$ or $10^{[40022]}$ or 100).

If EXPC is set to +3 (factory default), then the [40039,40040] upper totalization register will contain 1,234,567 (KGals) and the [40043] lower totalization register will contain 800 (Gals).

Regarding flow, all reported flow rates are multiplied by 1000 to eliminate the need for floating point formatting within the EtherMeter. In this case, if the actual flow rate is 987.6 GPM, then the [40005,40006] MODBUS holding register will report the flow as 987,600 (milliGallons/minute). If scaling to GPM is desired, then the polling device (master) must perform the scaling (divide by 1000).

13 DF1 AND ETHERNET/IP™ PROTOCOL SUPPORT

DF1. The EtherMeter provides elementary support for Rockwell Automation's DF1 serial protocol. This manual assumes that the user is well-versed in the DF1 Protocol. In order to learn more about the DF1 protocol, visit rockwellautomation.com.

The following functional subset of the DF1 protocol is supported by the EtherMeter:

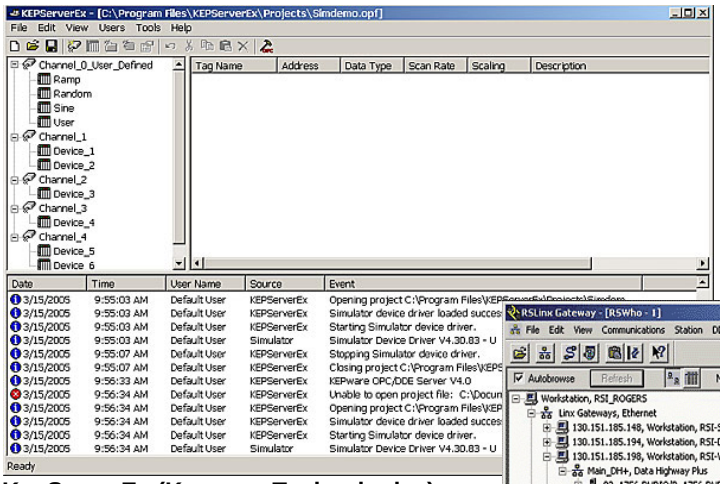
[CMD,FNC] = [0F,A2] - "Protected Typed Logical Read With 3 Address Fields"
[CMD,FNC] = [0F,AA] - "Protected Typed Logical Write With 3 Address Fields"

To a polling master PLC or computer, the EtherMeter's data is available within the Integer and Bit registers documented within this section. Read-only, Integer data is stored within the N7:0 register, and read-only Bit data is stored within B250 registers. The two (2) auxiliary digital outputs are mapped to the N10:0 register. When addressing Bit registers, is important to note that misaligned bit blocks, partial words, and masked/scattered bit reads are not supported.

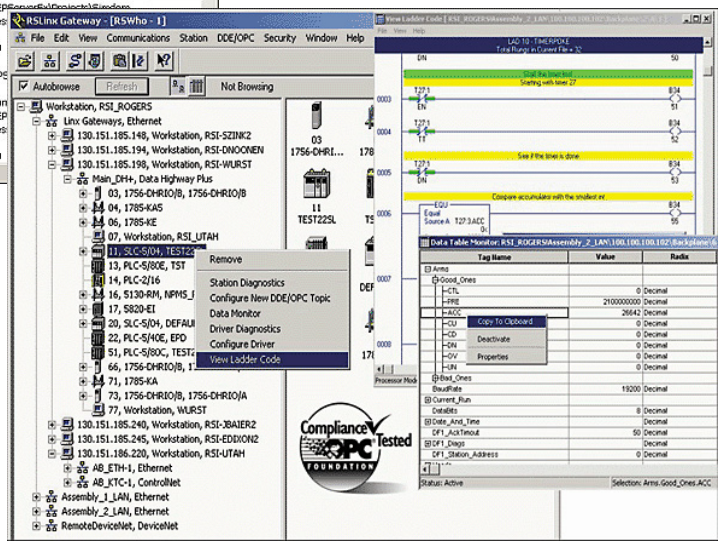
DF1-RadioModem and DF1-FullDuplex are both supported; and DF1-HalfDuplex is not supported. For error checking, either CRC-16 or BCC error checking may be selected.

In the DF1 protocol, the byte-order is "low-byte / high-byte" and the word order is "low-word / high-word". This method of ordering is also known as "Little-Endian". The DF1 byte-order and word-order are fixed within the EtherMeter and cannot be modified through the Setup Menu.

To test and/or verify DF1 communications with the EtherMeter, there are several useful computer programs available. SCADAmetrics recommends KepServerEx from Kepware Technologies (kepware.com), or RSLinx™ from Rockwell Automation (rockwellautomation.com). Assistance and support for these programs (and all 3rd-party software) may be obtained from their respective manufacturers.



KepServerEx (Kepware Technologies)



RSLinx (Rockwell Automation)

PROTECTED TYPED LOGICAL READ/WRITE WITH 3 ADDRESS FIELDS

[CMD,FNC,FILE#,FILETYPE] = [0F,A2,07,89] (READ N7 REGISTERS)

REGISTERS	DESCRIPTORS
N7:0-1*	METER 1 TOTAL (UNSCALED)
N7:2-3*	METER 2 TOTAL (UNSCALED)
N7:4-5**	FLOW 1 X 1000
N7:6-7**	FLOW 2 X 1000
N7:8	ROLLOVERS – METER 1
N7:9	ROLLOVERS – METER 2
N7:10	AIN 1 (0-10000)
N7:11	AIN 2 (0-10000)
N7:12	SUPPLY VOLTS X 10
N7:13	AUXILIARY DIGITAL I/O 1
N7:14	AUXILIARY DIGITAL I/O 2
N7:15	METER 1 READ FAULT
N7:16	METER 2 READ FAULT
N7:17-18*	SYSTEM UPTIME (MINUTES)
N7:19	METER 1 nDIGITS
N7:20	METER 2 nDIGITS
N7:21	METER 1 EXPONENT
N7:22	METER 2 EXPONENT
N7:23	METER 1 UNITS
N7:24	METER 2 UNITS
N7:25	METER 1 READ FAULT COUNTER
N7:26	METER 2 READ FAULT COUNTER
N7:27	METER 1 FLOW CALC METHOD
N7:28	METER 2 FLOW CALC METHOD
N7:29	METER 1 SAMPLE PERIOD (SECS)
N7:30	METER 2 SAMPLE PERIOD (SECS)
N7:31	METER 1 FLOW TIMEOUT (SECS)
N7:32	METER 2 FLOW TIMEOUT (SECS)
N7:33	METER 1 POWERUP (MSECS)
N7:34	METER 2 POWERUP (MSECS)
N7:35	METER 1 PROTOCOL (1=SENSUS,2=NEPTUNE)
N7:36	METER 2 PROTOCOL (1=SENSUS,2=NEPTUNE)
N7:37	COMPOUNDED METER EXPONENT (COMP EXP)
N7:38-39*	METER 1 UPPER TOTAL (ACTUAL / $10^{(COMP\ EXP)}$)
N7:40-41*	METER 2 UPPER TOTAL (ACTUAL / $10^{(COMP\ EXP)}$)
N7:42-43*	COMPOUND METER UPPER TOTAL (ACTUAL / $10^{(COMP\ EXP)}$)
N7:44	METER 1 LOWER TOTAL (ACTUAL % $10^{(COMP\ EXP)}$)
N7:45	METER 2 LOWER TOTAL (ACTUAL % $10^{(COMP\ EXP)}$)
N7:46	COMPOUND METER LOWER TOTAL (ACTUAL % $10^{(COMP\ EXP)}$)
N7:47-48**	COMPOUND FLOW X 1000

*DATA OCCUPYING THESE REGISTERS ARE 32-BIT UNSIGNED LONG INTEGERS.
**DATA OCCUPYING THESE REGISTERS ARE 32-BIT SIGNED LONG INTEGERS.
ALL OTHERS ARE 16-BIT SIGNED INTEGERS

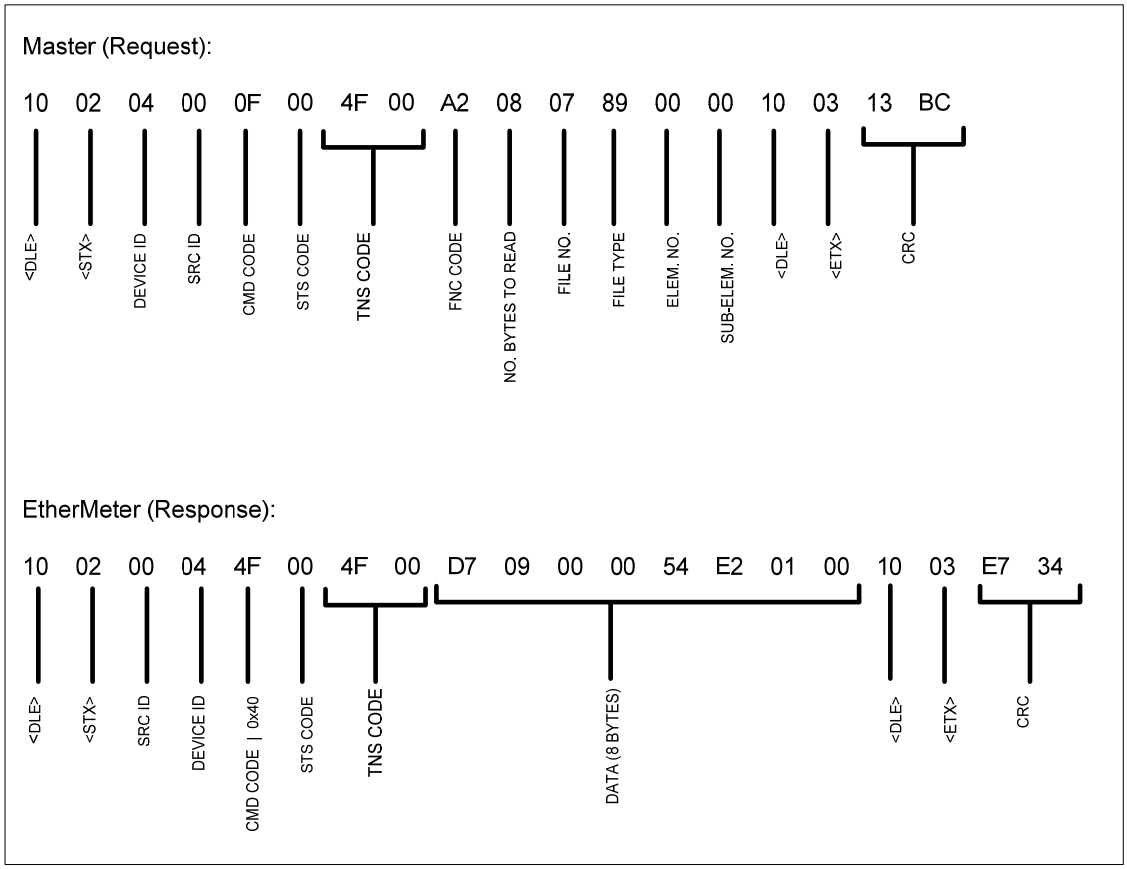
[CMD,FNC,FILE#,FILETYPE] = [0F,A2,FA,85] (READ B250 REGISTERS)

INPUTS	DESCRIPTORS
B250:0/0	AUXILIARY DIGITAL I/O 1
B250:0/1	AUXILIARY DIGITAL I/O 2
B250:0/2	METER 1 READ FAULT
B250:0/3	METER 2 READ FAULT
B250:0/4	METER 1 FORWARD FLOW (Y/N)
B250:0/5	METER 2 FORWARD FLOW (Y/N)
B250:0/6	METER 1 REVERSE FLOW (Y/N)
B250:0/7	METER 2 REVERSE FLOW (Y/N)

[CMD,FNC,FILE#,FILETYPE] = [0F,AA,0A,85] (WRITE B10 REGISTERS)

B10:0/0	AUXILIARY DIGITAL OUTPUT 1
B10:0/1	AUXILIARY DIGITAL OUTPUT 2

EtherMeter N-File, B-File Register Map.



Example DF1-RadioModem Request/Response.

Sample DF1 Commands:

The following samples are provided to familiarize the user with a few of the core DF1 commands. In all samples, the device address=4, and the protocol is DF1-RadioModem. Note that the users' responses will vary in accordance with the unique address and I/O state of each EtherMeter.

Read: Meter 1, Meter 2, Flow 1, Flow 2
DF1 [CMD,FNC] = [0F,A2]

Request: **10 02 04 00 0F 00 4F 00 A2 10 10 07 89 00 00 10 03 10 64**

Response (example):
```
10 02 00 04 4F 00 4F 00
D7 09 00 00 E8 E0 F5 05 00 00 00 00 00 00 00 00
10 03 3E 85
```

Write: Aux Digital Output 1, Aux Digital Output 2 (Turn Both Outputs 'ON')
DF1 [CMD,FNC] = [0F,AA]

Request: **10 02 04 00 0F 00 4F 00 AA 02 0A 85 00 00 03 00 10 03 77 33**

Response (example): **10 02 00 04 4F 00 4F 00 10 03 25 9C**

ETHERNET/IP™. The EtherMeter provides elementary support for EtherNet/IP™, an industrial communication protocol for Ethernet. EtherNet/IP™ was originally developed by Rockwell Automation and is now managed by ODVA. This manual assumes that the user is well-versed in the EtherNet/IP™ Protocol. In order to learn more about this protocol, please visit rockwellautomation.com or odva.org. The following document is a particularly useful reference for EtherNet/IP™ communications with Rockwell Automation PLC's:

"Communicating With Rockwell Automation Products Using EtherNet/IP Explicit Messaging"
http://www.rockwellautomation.com/enabled/pdf/eipexp1_2.pdf

The EtherMeter implements a functional subset of the EtherNet/IP™ Protocol:

- "Unconnected Explicit Messaging with Encapsulation of PCCC"
- "Class 3 Connected Explicit Messaging with Encapsulation of PCCC".

The EtherMeter responds to messages that utilize the following Service Request Codes:

- "Execute PCCC Service" (Code 0x4B)
- "VDH+ Service" (Code 0x4C)
- "Local Service" (Code 0x4D)

Please note that CIP™ and data subscriber/provider mechanisms are not supported; and fragmented EtherNet/IP™ packets are also not supported.

The EtherNet/IP™ server is available on TCP logical port 44818 of the EtherMeter, although the user may specify an alternate port through the Setup Menu.

Client Request:
“Register Session”:
28 Bytes:

```
[65 00]           [04 00]                         [00 00 00 00]    [00 00 00 00] [44 69 67 69 45 00 00 00] [00 00 00 00]
[REGISTER SESSION] [LEN OF DATA ATTACHED TO HEADER] [SESSION HANDLE] [STATUS]     [CONTEXT]                 [HEADER OPTIONS]

[01 00]                     [00 00]
[REGISTER PROTOCOL VERSION] [REGISTER OPTIONS]
```

Server (EtherMeter) Response:
“Register Session Response”
28 Bytes:

```
[65 00]           [04 00]                         [05 00 00 00]        [00 00 00 00] [44 69 67 69 45 00 00 00] [00 00 00 00]
[REGISTER SESSION] [LEN OF DATA ATTACHED TO HEADER] [SET SESSION HANDLE] [STATUS]     [CONTEXT]                 [HEADER OPTIONS]

[01 00]                     [00 00]
[REGISTER PROTOCOL VERSION] [REGISTER OPTIONS]
```

Client Request:
“Execute PCCC Service” Request, Unconnected Read, Encapsulated PCCC.
Client Requests Registers N7:0-3.
Totalization From Meter 1 and Meter 2.
63 Bytes (63 Bytes For Read, 65 Bytes For Write):

```
[6F 00]           [27 00]                         [05 00 00 00]    [00 00 00 00] [44 69 67 69 45 00 00 00] [00 00 00 00]
[PCCC OBJECT CODE] [LEN OF DATA ATTACHED TO HEADER] [SESSION HANDLE] [STATUS]     [CONTEXT]                 [HEADER OPTIONS]

[00 00 00 00]      [0A 00]
[INTERFACE HANDLE] [TIMEOUT]

[02 00]      [00 00 00 00]   [B2 00] [17 00]
[MULTIPLIER] [CPF ADDR ITEM] [UCMM]  [T-PDU LENGTH (VARIABLE)]

[4B]          [02]        [20 67 24 01] [07]         [25 03]         [97 81 3B 9D]
[EXEC PCC SVC] [PATH SIZE] [REQ PATH   ] [REQ ID LEN] [VEND ID(DIGI)] [4 LSB’S OF MAC ID]]

[0F                              [00]  [02 00] [A2]  [08]           [07]       [89]           [00]        [00]
[CMD:TYPED LOGICAL READ W/ 3 ADDR] [STS] [TNS]   [FNC] [N. BYTES REQ] [FILE NO.] [INTEGER TYPE] [ELEM.NO.]  [SUB-ELEM.NO.]
<------- [PCCC COMMAND] ----------------------------------------------------------------------------------------------------->
```

Server (EtherMeter) Response:
“Execute PCCC Service” Response, Unconnected Read, Encapsulated PCCC.
Response Contains Registers N7:0-3.
Totalization From Meter 1 (2519) and Meter 2 (123476).
63 Bytes (Payload Dependent):

```
[6F 00]           [27 00]                         [05 00 00 00]    [00 00 00 00] [44 69 67 69 45 00 00 00] [00 00 00 00]
[PCCC OBJECT CODE] [LEN OF DATA ATTACHED TO HEADER] [SESSION HANDLE] [STATUS]     [CONTEXT]                 [HEADER OPTIONS]

[00 00 00 00]      [0A 00]
[INTERFACE HANDLE] [TIMEOUT]

[02 00]      [00 00 00 00]   [B2 00] [17 00]
[MULTIPLIER] [CPF ADDR ITEM] [UCMM]  [T-PDU LENGTH (VARIABLE)]

[CB]            [00]     [00]         [00]              [07]         [00 00]         [00 00 00 C8]
[EXEC PCC REPLY] [RESERV] [GEN STATUS] [ADDL STATUS SIZE] [REQ ID LEN] [VEND ID(NULL)] [4 LSB’S OF MAC ID]

[4F]                             [00]  [02 00] [D7 09 00 00 54 E2 01 00]
[CMD:TYPED LOGICAL READ W/ 3 ADDR] [STS] [TNS]   [DATA PAYLOAD]
<------- [PCCC COMMAND] ------------------------------------------------>
```

Example EtherNet/IP Request/Response (Unconnected Messaging).

Client Request:
"Register Session":
28 Bytes:

```
[65 00]            [04 00]                          [00 00 00 00]    [00 00 00 00] [44 69 67 69 45 00 00 00] [00 00 00 00]
[REGISTER SESSION] [LEN OF DATA ATTACHED TO HEADER] [SESSION HANDLE] [STATUS]      [CONTEXT]                 [HEADER OPTIONS]

[01 00]                     [00 00]
[REGISTER PROTOCOL VERSION] [REGISTER OPTIONS]
```

Server (EtherMeter) Response:
"Register Session Response"
28 Bytes:

```
[65 00]            [04 00]                          [05 00 00 00]        [00 00 00 00] [44 69 67 69 45 00 00 00] [00 00 00 00]
[REGISTER SESSION] [LEN OF DATA ATTACHED TO HEADER] [SET SESSION HANDLE] [STATUS]      [CONTEXT]                 [HEADER OPTIONS]

[01 00]                     [00 00]
[REGISTER PROTOCOL VERSION] [REGISTER OPTIONS]
```

Client Request:
Unconnected "Forward Open" Request For Class 3 Connection
86 Bytes (88 Bytes If Conn Path Length = 3 Words):

```
[6F 00]            [3E 00]                          [05 00 00 00]    [00 00 00 00] [C0 A8 01 BF 00 00 01 00] [00 00 00 00]
[PCCC OBJECT CODE] [LEN OF DATA ATTACHED TO HEADER] [SESSION HANDLE] [STATUS]      [CONTEXT]                 [HEADER OPTIONS]

[00 00 00 00]      [00 04]
[INTERFACE HANDLE] [TIMEOUT]

[02 00]                [00 00]     [00 00]             [B2 00] [2E 00]
[ITEM COUNT (0x0002)] [ITEM TYPE] [ITEM DATA LENGTH] [UCMM]  [T-PDU LENGTH (VARIABLE)]

[54]            [02]                     [20 06 24 01]       [0A 0E]           [2D 23 82 F2] [EF 22 82 F2]
[FWD OPEN REQ] [REQ PATH SIZE (WORDS)] [CLASS,CM OBJ,INST] [TICKS/PRIORITY] [OT-CID]      [TO-CID]

[02 10]    [01 00]              [F6 1D 4F 40] [02]                [00 00 00] [C0 C6 2D 00] [02 43]
[CONN S/N] [ORIG VEND ID(ROCKW)] [ORIG S/N]    [CONN TIMEOUT MULT] [RESERVED] [OT RPI]      [OT PARAMS]

[C0 C6 2D 00] [02 43]      [A3]                  [02]                      [20 02 24 01]
[TO RPI]      [TO PARAMS]  [TRANSP CLASS/TRIGGER] [WORDS(16) IN CONN PATH] [CONN PATH]
```

Server (EtherMeter) Response:
Unconnected "Forward Open" Reply For Class 3 Connection
70 Bytes:

```
[6F 00]            [2E 00]                          [05 00 00 00]    [00 00 00 00] [C0 A8 01 BF 00 00 01 00] [00 00 00 00]
[PCCC OBJECT CODE] [LEN OF DATA ATTACHED TO HEADER] [SESSION HANDLE] [STATUS]      [CONTEXT]                 [HEADER OPTIONS]

[00 00 00 00]      [00 04]
[INTERFACE HANDLE] [TIMEOUT]

[02 00]                [00 00]     [00 00]             [B2 00] [1E 00]
[ITEM COUNT (0x0002)] [ITEM TYPE] [ITEM DATA LENGTH] [UCMM]  [T-PDU LENGTH (VARIABLE)]

[D4]            [00]       [00]          [00]                    [6F 32 74 02] [EF 22 82 F2]
[FWD OPEN RESP] [RESERVED] [GEN STATUS] [SIZE OF ADDL STATUS] [OT-CID]      [TO-CID]

[02 10]    [01 00]          [F6 1D 4F 40] [20 FD 4B 00] [20 FD 4B 00] [00]                [00]
[CONN S/N] [ORIG VEND ID]   [ORIG S/N]    [OT API]      [TO API]      [SIZE OF APP REPLY] [RESERVED]
```

Client Request:
"Execute PCCC Service" Request, Send Unit Data, Encapsulated PCCC.
Client Requests Registers N7:0-7.
Totalization And Flow From Meter 1 and Meter 2.
69 Bytes (69 For Read, 71 For Write):

```
[70 00]                      [2D 00]                          [05 00 00 00]    [00 00 00 00] [C0 A8 01 BF 00 00 01 01] [00 00 00 00]
[SEND UNIT DATA T3 CONN MSG] [LEN OF DATA ATTACHED TO HEADER] [SESSION HANDLE] [STATUS]      [CONTEXT]                 [HEADER OPTIONS]

[00 00 00 00]      [0A 00]
[INTERFACE HANDLE] [TIMEOUT]

[02 00]                [A1 00]                     [04 00]      [6F 32 74 02] [B1 00]               [19 00]
[ITEM COUNT (0x0002)] [CONN ADDR ITEM (0x00A1)] [CID LENGTH] [OT-CID]      [CONNECTED DATA ITEM] [T-PDU LENGTH (VARIABLE)]

[01 00]     [4B]             [02]               [20 67 24 01]           [07]          [01 00]          [F6 1D 4F 40]
[REQUESTOR] [EXEC PCCC SVC] [PATH SIZE (WORDS)] [CLASS PCCC,INSTANCE 1] [REQ ID LEN] [VEND ID(ROCKW)] [ORIG S/N]

[0F]                                [00]  [01 00] [A2]  [10]          [07]       [89]            [00]       [00]
[CMD:TYPED LOGICAL READ W/ 3 ADDR] [STS] [TNS]   [FNC] [N BYTES REQ] [FILE NO.] [INTEGER TYPE] [ELEM.NO.] [SUB-ELEM.NO.]
<------- [PCCC COMMAND] ----------------------------------------------------------------------------------------------------->
```

Server (EtherMeter) Response:
"Execute PCCC Service" Response, Send Unit Data, Encapsulated PCCC.
Response Contains Registers N7:0-7.
Totalization And Flow From Meter 1 (2519) and Meter 2 (123476).
77 Bytes (Payload Dependent):

```
[70 00]                      [35 00]                          [05 00 00 00]    [00 00 00 00] [C0 A8 01 BF 00 00 01 01] [00 00 00 00]
[SEND UNIT DATA T3 CONN MSG] [LEN OF DATA ATTACHED TO HEADER] [SESSION HANDLE] [STATUS]      [CONTEXT]                 [HEADER OPTIONS]

[00 00 00 00]      [0A 00]
[INTERFACE HANDLE] [TIMEOUT]

[02 00]                [A1 00]                     [04 00]      [EF 22 82 F2] [B1 00]               [21 00]
[ITEM COUNT (0x0002)] [CONN ADDR ITEM (0x00A1)] [CID LENGTH] [TO-CID]      [CONNECTED DATA ITEM] [T-PDU LENGTH (VARIABLE)]

[01 00]     [CB]             [00]      [00]          [00]                [07]          [00 00]          [01 00 00 00]
[REQUESTOR] [EXEC PCCC REPLY] [RESERV] [GEN STATUS] [ADDL STATUS SIZE] [REQ ID LEN] [VEND ID(NULL)] [S/N]

[4F]                                [00]  [01 00] [00 00 13 00 F5 05 F8 E0 00 00 00 00 00 00 00 00]
[CMD: TYPED LOGICAL READ W/ 3 ADDR] [STS] [TNS]   [DATA PAYLOAD]
<------- [PCCC COMMAND] ------------------------------------------------------------------------>
```

Example EtherNet/IP Request/Response (Class 3 Connected Messaging).

TOTALIZATION AND FLOW DATA FORMAT:

The EtherMeter was designed in such a way as to simplify and compress the formatting of all reported data. As shown in the previous charts, no floating point or 64-bit registers are implemented in the N7 registers, as all data is represented internally as 32-bit long integers (signed or unsigned) and 16-bit signed integers.

In order to achieve a high level of simplicity and prevent integer overflows, separate exponential scale factors and multipliers are provided in certain N7 registers.

If fully-scaled totalization data is desired, then 64-bit data processing may be required by the DF1 master polling PLC or computer. In most instances, however, 32-bit data manipulation will suffice.

TOTALIZATION HELPER FORMULAS:

The following calculations are examples helper formulas that may be implemented within the master. When deciding whether to use 64-bit versus 32-bit data manipulation routines at the master, it is recommended that the user factor in the largest expected meter totalization value (meter-specific), and consider that the largest possible 32-bit unsigned long integer is 4,294,967,295.

Meter 1 Actual Total = [METER 1 UPPER TOTAL] x $[10^{[\text{COMP EXP}]}]$ + [METER 1 LOWER TOTAL]
= [N7:38,39] x $[10^{[\text{N7:37}]}]$ + [N7:44,45]

Meter 2 Actual Total = [METER 2 UPPER TOTAL] x $[10^{[\text{COMP EXP}]}]$ + [METER 2 LOWER TOTAL]
= [N7:40,41] x $[10^{[\text{N7:37}]}]$ + [N7:45]

Comp. Actual Total = [COMP. UPPER TOTAL] x $[10^{[\text{COMP EXP}]}]$ + [COMP. LOWER TOTAL]
= [N7:42,43] x $[10^{[\text{N7:37}]}]$ + [N7:46]

Alternatively:

Meter 1 Actual Total = [METER 1 TOTAL UNSCALED] x $[10^{[\text{METER 1 EXPONENT}]}]$
+ [ROLLOVERS METER 1] x $[10^{[\text{METER 1 nDIGITS}]}]$ x $[10^{[\text{METER 1 EXPONENT}]}]$
= [N7:0,1] x $[10^{[\text{N7:21}]}]$ + [N7:8] x $[10^{[\text{N7:19}]}]$ x $[10^{[\text{N7:21}]}]$

Meter 2 Actual Total = [METER 2 TOTAL UNSCALED] x $[10^{[\text{METER 2 EXPONENT}]}]$
+ [ROLLOVERS METER 2] x $[10^{[\text{METER 2 nDIGITS}]}]$ x $[10^{[\text{METER 2 EXPONENT}]}]$
= [N7:2,3] x $[10^{[\text{N7:22}]}]$ + [N7:9] x $[10^{[\text{N7:20}]}]$ x $[10^{[\text{N7:22}]}]$

FLOW RATE HELPER FORMULAS:

The following are possible flow rate helper formulas that may be implemented within a DF1 master polling PLC or computer:

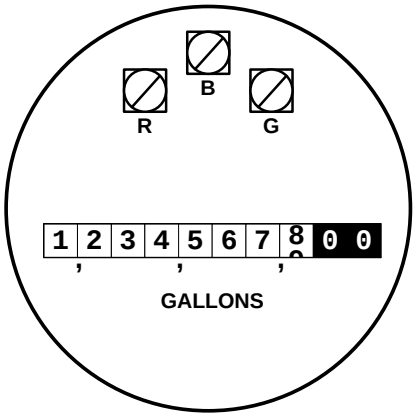
Meter 1 Actual Flow = [FLOW 1] / 1000
= [N7:4,5] / 1000

Meter 2 Actual Flow = [FLOW 2] / 1000
= [N7:6,7] / 1000

Comp. Actual Flow = [COMP. FLOW] / 1000
= [N7:47,48] / 1000

EXAMPLE:

Consider the following case of a meter register installed on meter channel 1. This register contains 8 variable digits plus two (2) fixed zeros on the right. (EXP1=+2.)



In this case, the actual total is 1,234,567,800 gallons. However, the [N7:0,1] register will report the total as: 12,345,678. If scaling to GALLONS is desired, then the polling device (master) must perform the scaling (multiply by $10^{(EXPn)}$ or $10^{[N7:21]}$ or 100).

If EXPC is set to +3 (factory default), then the [N7:38,39] upper totalization register will contain 1,234,567 (KGals) and the [N7:42] lower totalization register will contain 800 (Gals).

Regarding flow, all reported flow rates are multiplied by 1000 to eliminate the need for floating point formatting within the EtherMeter. In this case, if the actual flow rate is 987.6 GPM, then the [N7:4,5] register will report the flow as 987,600 (milliGallons/minute). If scaling to GPM is desired, then the polling device (master) must perform the scaling (divide by 1000).

14 ADAM-4000 PROTOCOL SUPPORT

The EtherMeter is available with ADAM-4000 protocol support (Optional. ADAM-Version Only). This portion of the manual assumes that the user is well-versed in the ADAM-4000 Protocol. In order to learn more about the ADAM-4000 protocol, visit www.advantech.com.

The following subset of the ADAM-4000 protocol is supported by the EtherMeter:

#AAn	- Read Analog Inputs (32 bit signed hexadecimal format)
$AA6	- Read Discrete Inputs
#AA100d	- Write Discrete Outputs
$AAM	- Read Device ID

The checksum option is available, but turned OFF by default. Checksum may be enabled via the Setup Menu.

To test and/or verify ADAM-4000 communications with the EtherMeter, a terminal program (such as HyperTerminal) may be used.

The ADAM-4080D 2-Channel Pulse Counter Input Module is often used to interface to pulse-output meter registers. As an improvement, the EtherMeter may be used as an ADAM-compatible replacement for interfacing to encoder-output meter registers.

FUNCTION: #AAn (READ ANALOG INPUTS)*

REGISTERS (Hex)	DESCRIPTORS
0	METER 1 TOTAL (UNSCALED)
1	METER 2 TOTAL (UNSCALED)
2	FLOW 1 X 1000
3	FLOW 2 X 1000
4	ROLLOVERS – METER 1
5	ROLLOVERS – METER 2
6	AIN 1 (0-10000)
7	AIN 2 (0-10000)
8	SUPPLY VOLTS X 10
9	AUXILIARY DIGITAL I/O 1
A	AUXILIARY DIGITAL I/O 2
B	METER 1 READ FAULT
C	METER 2 READ FAULT
D	SYSTEM UPTIME (MINUTES)
E	METER 1 nDIGITS
F	METER 2 nDIGITS

*AA : HEX DEVICE ADDRESS
n : HEX INPUT CHANNEL (0-F)

FUNCTION: $AA6 (READ DISCRETE INPUTS)*

INPUTS	DESCRIPTORS
0	AUXILIARY DIGITAL I/O 1
1	AUXILIARY DIGITAL I/O 2
2	METER 1 READ FAULT
3	METER 2 READ FAULT
4	METER 1 FORWARD FLOW (Y/N)
5	METER 2 FORWARD FLOW (Y/N)
6	METER 1 REVERSE FLOW (Y/N)
7	METER 2 REVERSE FLOW (Y/N)

*AA : HEX DEVICE ADDRESS

FUNCTION: #AA1n0d (WRITE RELAY)*

COILS	DESCRIPTOR
0	AUXILIARY DIGITAL OUTPUT 1
1	AUXILIARY DIGITAL OUTPUT 2

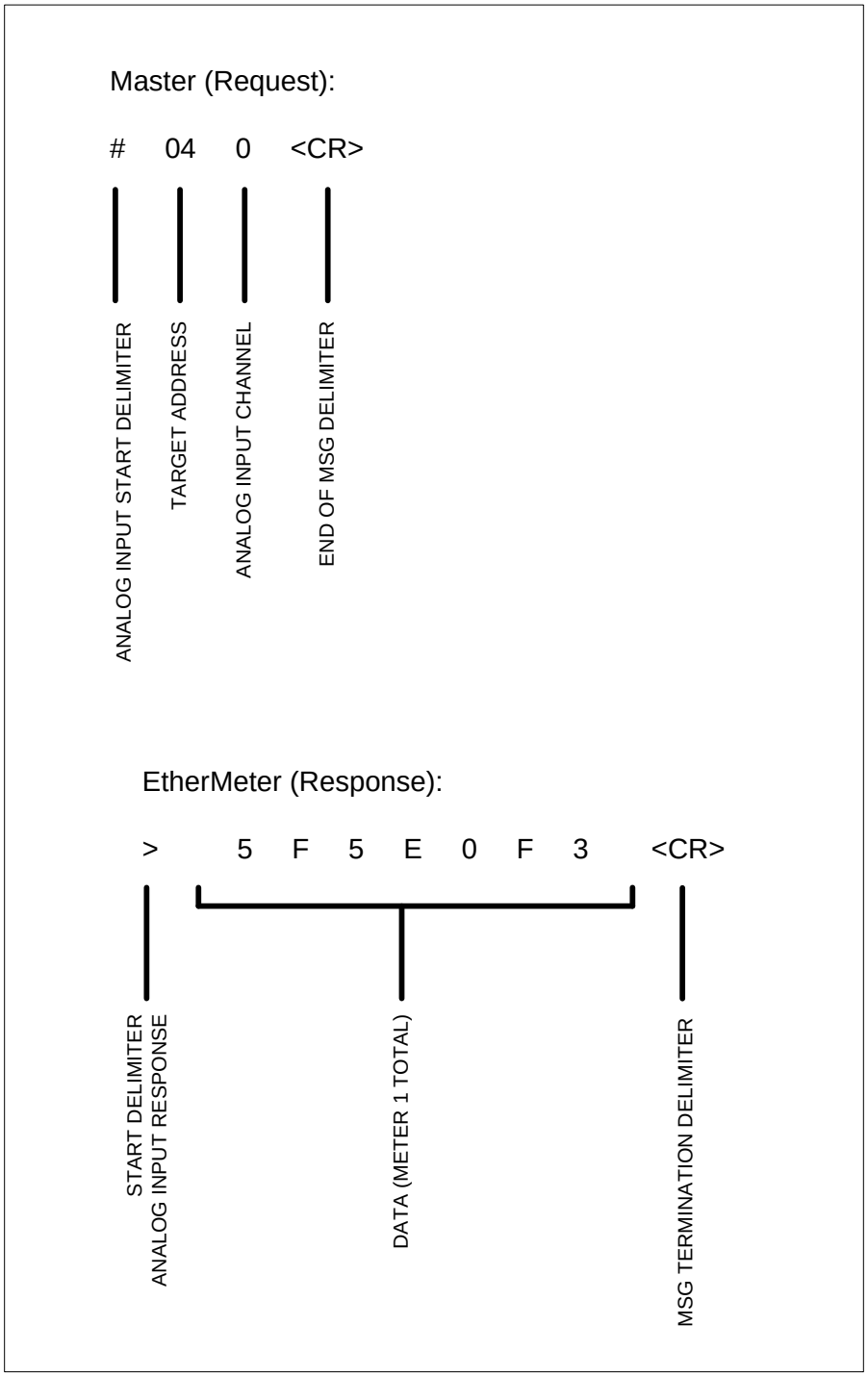
*AA : HEX DEVICE ADDRESS
n : 0 (AUX 1) or 1 (AUX 2)
d : 1 (ON) or 2 (OFF)

FUNCTION: $AAM (READ DEVICE ID)*

RESPONSE: !AAETHERMETER<CR>

*AA : HEX DEVICE ADDRESS

EtherMeter ADAM-4000 Register Map.



Example ADAM-4000 Request/Response.

Note the response, 5F5E0F3 hexadecimal, which corresponds to 99999987 decimal. Note that all ADAM analog data is transmitted in hexadecimal format.

TOTALIZATION AND FLOW DATA FORMAT:

The EtherMeter was designed in such a way as to simplify and compress the formatting of all reported data. As shown in the previous charts, no floating point or 64-bit registers are implemented in the ADAM-4000 holding registers, as all data is represented internally as 32-bit long integers (signed or unsigned) and 16-bit signed integers.

In order to achieve a high level of simplicity and prevent integer overflows, separate exponential scale factors and multipliers are provided in certain ADAM-4000 registers.

If fully-scaled totalization data is desired, then 64-bit data processing may be required by the master polling PLC or computer. In most instances, however, 32-bit data manipulation will suffice.

TOTALIZATION HELPER FORMULAS:

The following calculations are examples helper formulas that may be implemented within the master. When deciding whether to use 64-bit versus 32-bit data manipulation routines, factor in the largest expected meter totalization value (meter-specific), and consider that the largest possible 32-bit unsigned long integer is 4,294,967,295.

Meter 1 Actual Total = [METER 1 TOTAL UNSCALED] x $[10^{[\text{METER 1 EXPONENT}]}]$
+ [ROLLOVERS METER 1] x $[10^{[\text{METER 1 nDIGITS}]}]$ x $[10^{[\text{METER 1 EXPONENT}]}]$
= [ADAM-0x00] x $[10^{[\text{EXP1}]}]$
+ [ADAM-0x04] x $[10^{[\text{ADAM-0x0E}]}]$ x $[10^{[\text{EXP1}]}]$

Meter 2 Actual Total = [METER 2 TOTAL UNSCALED] x $[10^{[\text{METER 2 EXPONENT}]}]$
+ [ROLLOVERS METER 2] x $[10^{[\text{METER 2 nDIGITS}]}]$ x $[10^{[\text{METER 2 EXPONENT}]}]$
= [ADAM-0x01] x $[10^{[\text{EXP2}]}]$
+ [ADAM-0x05] x $[10^{[\text{ADAM-0x0F}]}]$ x $[10^{[\text{EXP2}]}]$

FLOW RATE HELPER FORMULAS:

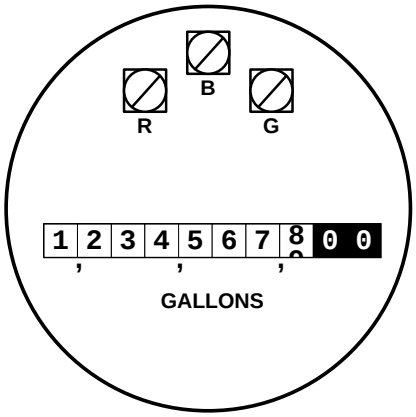
The following are possible flow rate helper formulas that may be implemented within a MODBUS master polling PLC or computer:

Meter 1 Actual Flow = [FLOW 1] / 1000
= [ADAM-0x02] / 1000

Meter 2 Actual Flow = [FLOW 2] / 1000
= [ADAM-0x03] / 1000

EXAMPLE:

Consider the following case of a meter register installed on meter channel 1. This register contains 8 variable digits plus two (2) fixed zeros on the right. (EXP1=+2.)



In this case, the actual total is 1,234,567,800 gallons. However, the [0x00] ADAM-4000 holding register will report the total as: 12,345,678. If scaling to GALLONS is desired, then the polling device (master) must perform the scaling (multiply by $10^{(EXPn)}$ or 100).

Regarding flow, all reported flow rates are multiplied by 1000 to eliminate the need for floating point formatting within the EtherMeter. In this case, if the actual flow rate is 987.6 GPM, then the [0x02] ADAM-4000 holding register will report the flow as 987,600 (milliGallons/minute). If scaling to GPM is desired, then the polling device (master) must perform the scaling (divide by 1000).

Also, keep in mind that the EtherMeter reports all ADAM-4000 analog data in hexadecimal ASCII format.

15 ASCII PROTOCOL SUPPORT

Many PLC's and RTU's are equipped with extra serial ports that are capable of collecting data from raw ASCII terminal devices such as bar code readers. For compatibility with these PLC's, the EtherMeter provides a "Raw ASCII Protocol" output.

When the EtherMeter is set to "Raw ASCII" mode (available via the Setup Menu), the following data is transmitted from the active serial port every three (3) seconds:

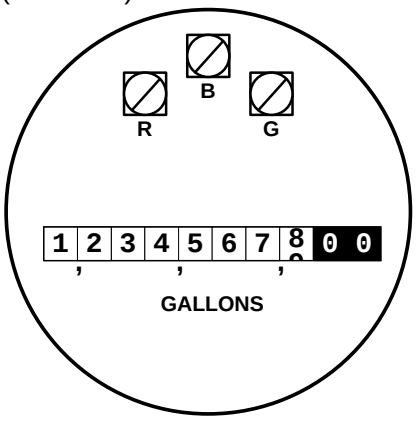
: <TOTAL1> ; <TOTAL2> ; <FLOW1> ; <FLOW2> ; <ROLLOVERS1> ; <ROLLOVERS2> ; <ANALOG_IN1> ; <ANALOG_IN2> ; <AUX_DIGITAL_IO_2> ; <AUX_DIGITAL_IO_2> ; <METER_FAULT1> ;<METER_FAULT2> <CR> <LF>

Each transmission is preceded by a ':' delimiter, and ended with a <CR><LF> delimiter. There are no spaces or carriage returns between the data fields, as each field is separated by a ';' delimiter.

TOTALIZATION AND FLOW DATA FORMAT:

The EtherMeter was designed in such a way as to simplify and compress the formatting of all reported data. In order to achieve this level of simplicity, the scale factors (EXP1 and EXP2) have been stripped from the reported totals (Note: the 2x16 LCD display and web page provide scaled displays).

For example, consider the following case of an 8-digit register plus two (2) fixed zeros on the right (EXPn=+2):

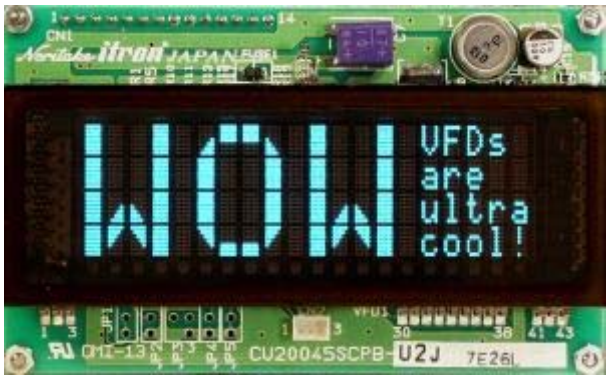


In this case, the actual total is 1,234,567,800 gallons. However, the ASCII protocol will report the total as: 12345678. If scaling to GALLONS is desired, then the reading device must perform the scaling (multiply by 100).

Regarding flow, all reported flow rates are multiplied by 1000 to eliminate the need for floating point formatting. In this case, if the actual flow rate is 987.6 GPM, then the ASCII protocol will report the flow as 987600 (MilliGallons Per Minute). If scaling to GPM is desired, then the reading device must perform the scaling (divide by 1000). Also, keep in mind that all reported ASCII data is formatted in decimal.

16 SERIAL DISPLAY PROTOCOL SUPPORT

The EtherMeter is available with Remote Serial Display protocol support (Optional. VFD-Version Only). When utilized in this mode, the EtherMeter may be used to drive an economical remote serial display, such as the VFD-420 Vacuum Fluorescent Display by SEETRON (Scott Edwards Electronics, www.seetron.com).



The VFD-420 Vacuum Fluorescent Display, Manufactured By SEETRON.

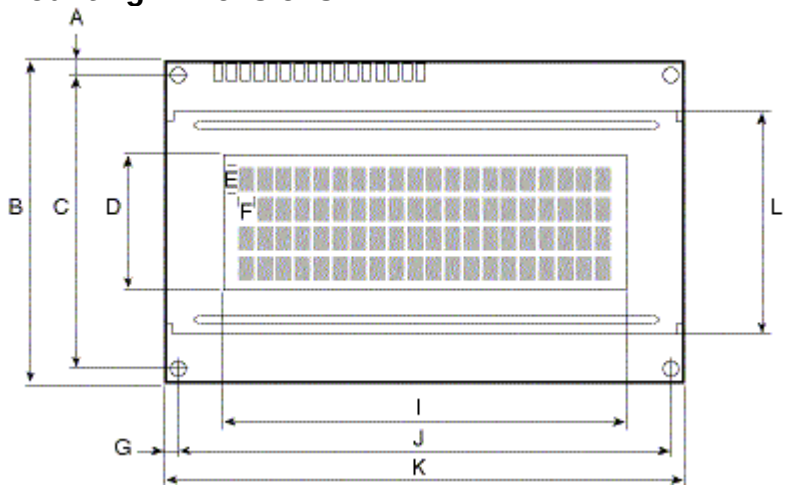
The "Serial Display" Protocol is similar to the "Raw ASCII" protocol, except that textual descriptions are transmitted along with the data, and screen position control codes are transmitted so as to format the display.

The following screens are displayed in a repeating rotation:

Displayed Data	On-Screen Duration (Seconds)
Meter 1 Total	3
Meter 2 Total	3
Meter 1 Flow	3
Meter 2 Flow	3
Supply Voltage (Volts)	1.5
Analog Input #1 (0-100%)	1.5
Analog Input #2 (0-100%)	1.5
Aux Digital I/O 1 Status (ON/OFF)	1.5
Aux Digital I/O 2 Status (ON/OFF)	1.5
Active Serial Protocol	1.5
Device Address	1.5
Device Uptime (minutes)	1.5
Firmware Version	1.5
User-Defined Banner Text	3

Note that any of the above screens may be disabled (skipped) through the Setup Menu.

Mounting Dimensions:



A	y offset edge to hole center (top & bottom)	2.50
B	y pcb height	60.00
C	y hole spacing (inside pair)	55.00
D	y screen opening	20.90
E	y character size	4.70
F	x character size	2.40
G	x offset pcb edge to hole center	2.50
H	x screen frame	N/A
I	x screen opening	70.80
J	x hole spacing	93.00
K	x pcb width	98.00
L	y frame height	N/A
-	mounting hole diameter	2.50
-	frame depth	14.00
All dimensions in millimeters. Tolerance is +/- 0.50mm. Maximum depth (front of screen to highest point on pcb) is 26mm.		

Notes:

1. A separate 5VDC (500mA) power supply is required for the display.

2. The display may be mounted to the front door of a small enclosure.
   A rectangular panel punch may be required.
   For the SEETRON VFD420 Display, the following Greenlee punch is recommended:

   P/N 60062
   Hole Size 1.378 X 3.228in. (35.0 X 82.0mm)

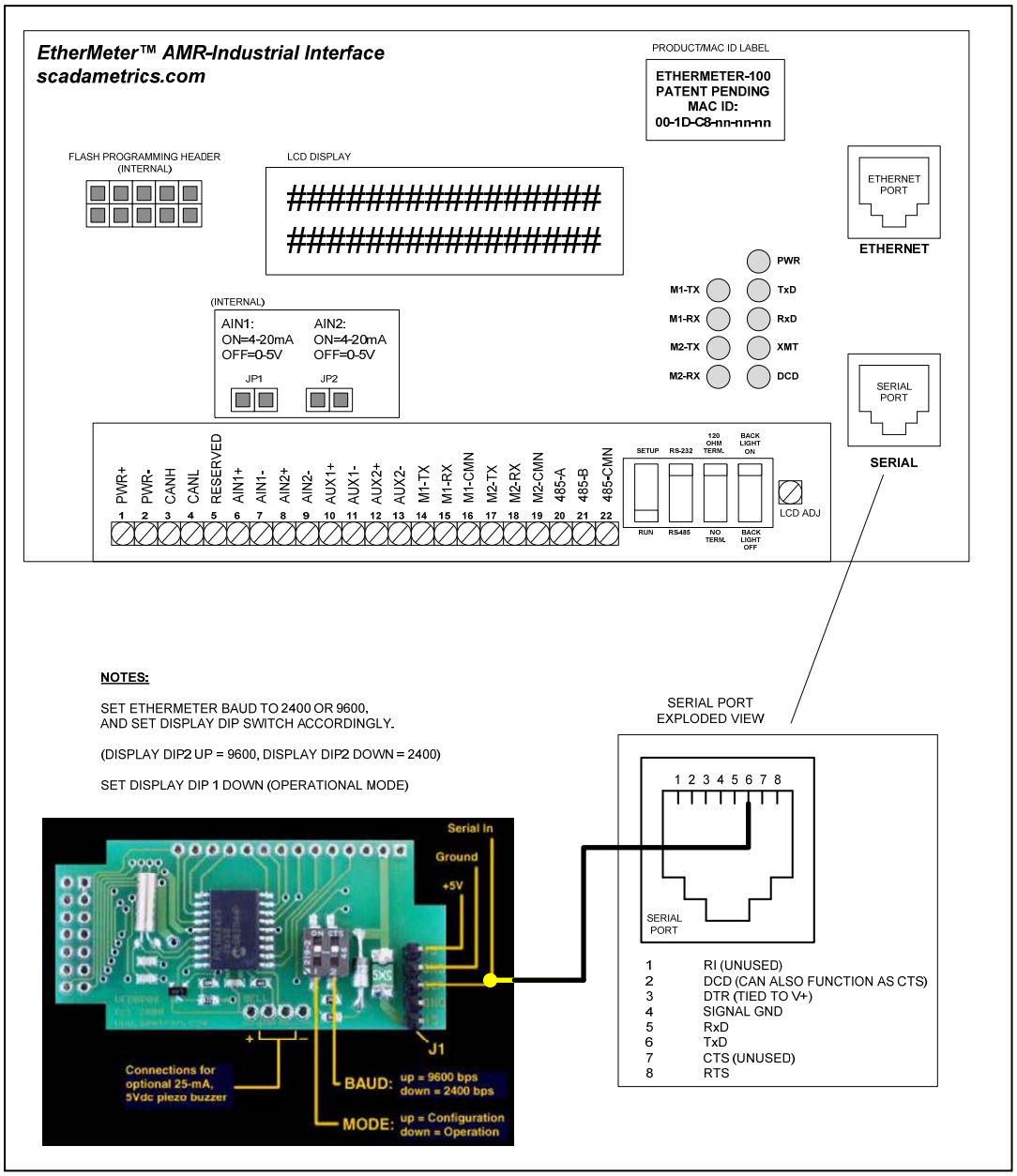
3. SCADAmetrics offers an outdoor-grade Lexan® bezel kit, which provides a wider, waterproof adhesive band than the similar model offered by SEETRON:

   SCADAMETRICS P/N: EBEZ-420.

4. When used, a serial display monopolizes the serial port. However, simultaneous MODBUS/TCP/UDP capability is operational by default.

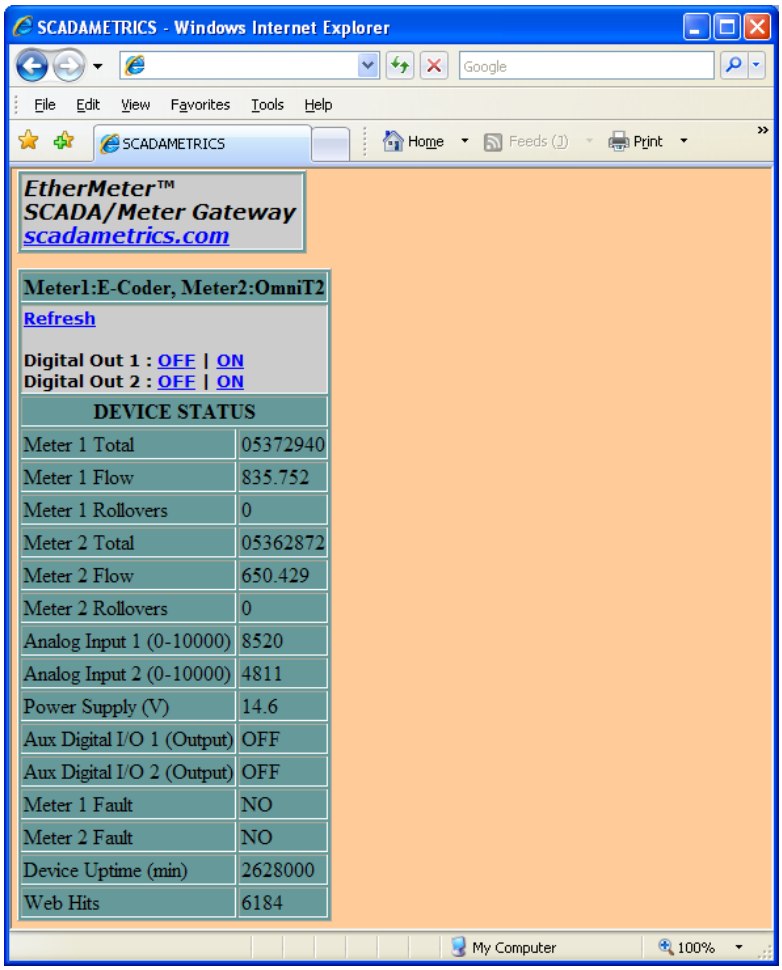
5. SEETRON links are provided in Section 17 “References”.

EtherMeter™–to–Serial Display Wiring Diagram:



17 HTTP WEB SERVER

The EtherMeter offers an integral web server, which is active on TCP logical port 80. The device also features a “Ping Server”, which is useful for locating and troubleshooting the EtherMeter on a network. Note that both static IP and dynamic IP (DHCP) addressing is supported. (Static or Dynamic IP Address selection is made in the Setup Menu.) The unique MAC ID of each EtherMeter is printed on the front cover of the unit.

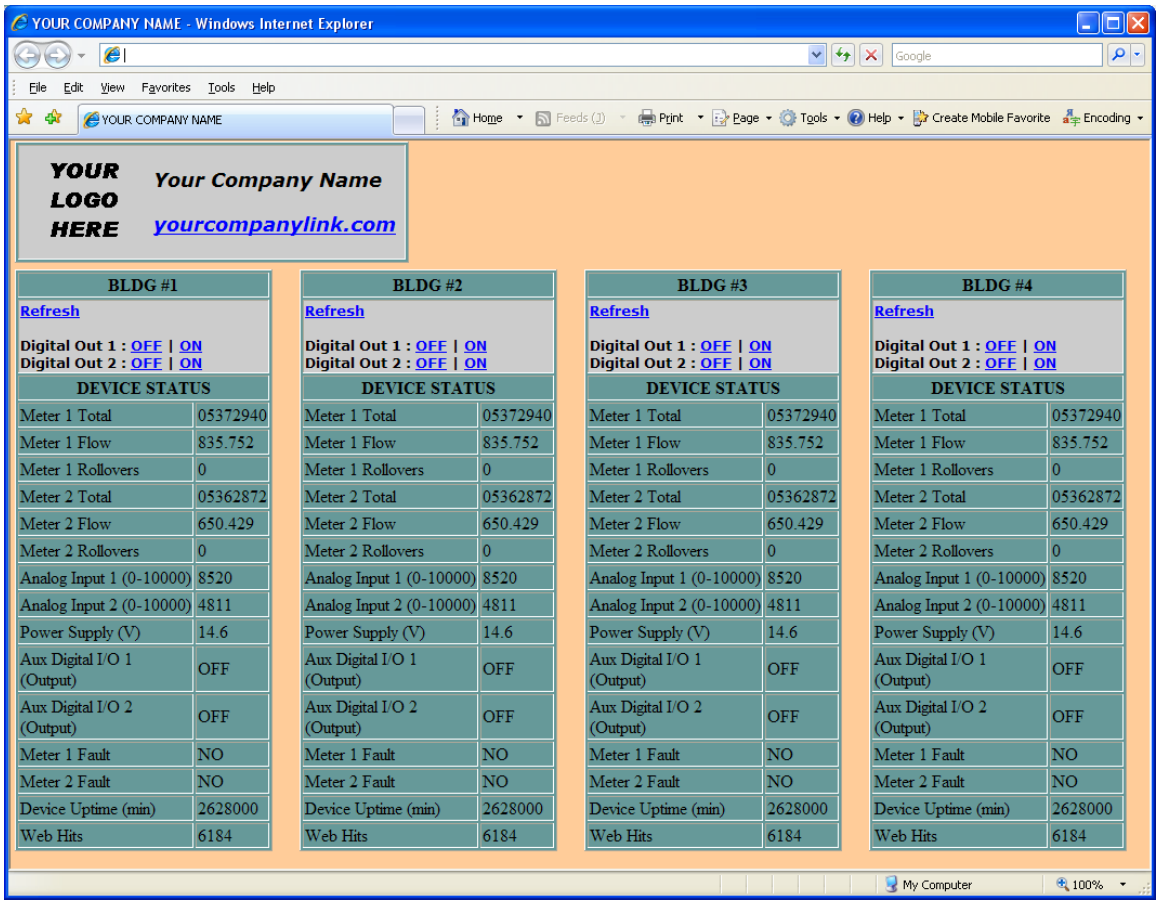


A Screen Image of a page served by the EtherMeter Web Server.

The following web pages are served by the EtherMeter:

/index.html	A dual-frame web page, containing s.html and b.html
/s.html	The SCADAmetrics splash screen web page
/b.html	The basic data web page

Through the use of an off-board web server, customized, frame-based web pages may be developed for displaying data from multiple installed EtherMeters™. The following web page is a simple example:



Source HTML:

```
<html><head><title>YOUR COMPANY NAME</title></head>
<frameset rows="118,*" framespacing="0" frameborder="0">
<frame src="http://yourserver/yourfile.html" marginheight="1" marginwidth="4">
<frameset cols="25%,25%,25%,25%" framespacing="0" frameborder="0">
<frame src="http://192.168.1.101/b.html " marginheight="1" marginwidth="4">
<frame src="http://192.168.1.102/b.html " marginheight="1" marginwidth="4">
<frame src="http://192.168.1.103/b.html " marginheight="1" marginwidth="4">
<frame src="http://192.168.1.104/b.html " marginheight="1" marginwidth="4">
</frameset>
</frameset>
</html>
```

18 TELNET SERVER

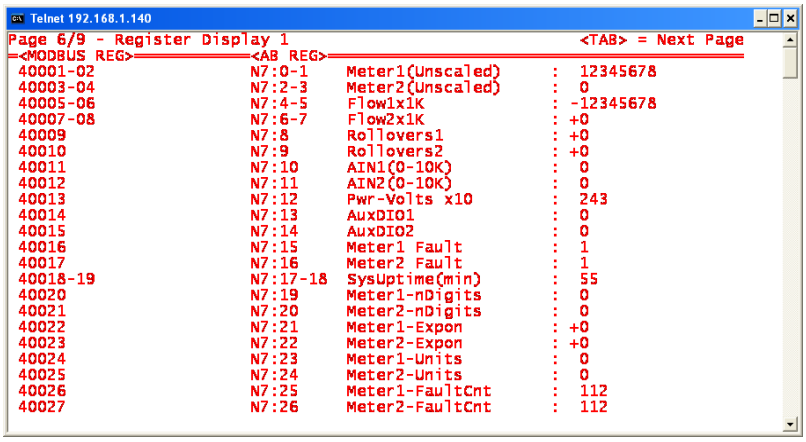
The EtherMeter provides a basic integrated TELNET server. With the use of TELNET client software, the user may log in to the EtherMeter from a remote node on the network to perform setup and maintenance tasks. However, only one (1) remote user may TELNET to the EtherMeter at any given time.

Windows® TELNET (bundled with Microsoft® Windows®) and HyperTerminal Private Edition™ (By Hilgraeve) are the recommended and supported TELNET clients.

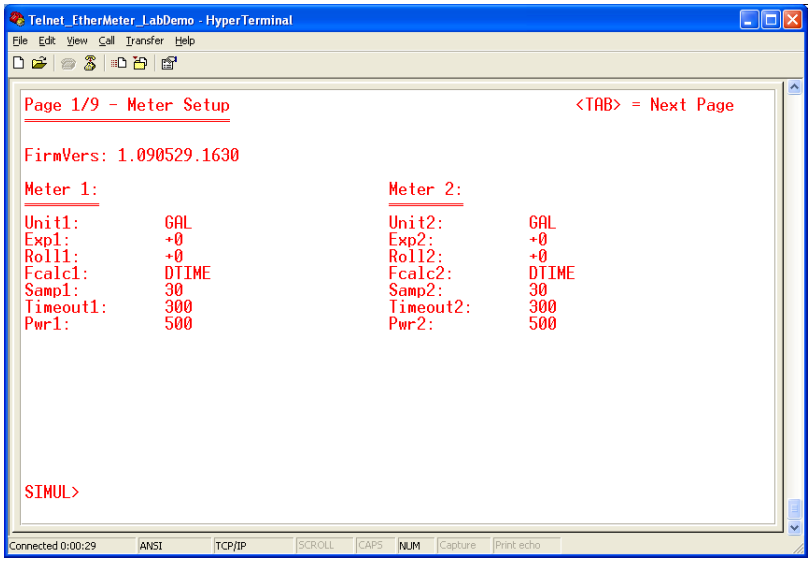
To initiate a TELNET session, the user should specify the IP address of the EtherMeter and the TELNET TCP Port (23). Once connected, a login prompt will appear.

Username: **emeter** (case-insensitive. May not be changed.)
Password: **emeter** (case-insensitive. May be changed through the Setup Menu.)

Once logged in, the user has full access to the Setup Menu. (See Chapter 11 for details.) After the desired maintenance tasks are completed, the user may log out by typing the following command at the prompt: **logout**



Screen Image of a Microsoft® Windows® TELNET Client Session.


Telnet_EtherMeter_LabDemo - HyperTerminal
File Edit View Call Transfer Help
Page 1/9 - Meter Setup <TAB> = Next Page
FirmVers: 1.090529.1630
Meter 1: Meter 2:
Unit1: GAL Unit2: GAL
Exp1: +0 Exp2: +0
Roll1: +0 Roll2: +0
Fcalc1: DTIME Fcalc2: DTIME
Samp1: 30 Samp2: 30
Timeout1: 300 Timeout2: 300
Pwr1: 500 Pwr2: 500
SIMUL>
Connected 0:00:29 ANSI TCP/IP SCROLL CAPS NUM Capture Print echo

Screen Image of a HyperTerminal Private Edition™ TELNET Client Session.

19 NETWORK SECURITY

The networking capabilities of the EtherMeter are very basic; and therefore the device is not designed to be staged at network locations where it would be exposed to Internet threats.

When an EtherMeter is installed within an industrial network that features a Gateway to the Internet, a firewall should be properly installed and configured to shield the EtherMeter, as well as all other industrial controls, from the vagaries of unfiltered Internet traffic.

20 REFERENCES

METERS:

Itron (Actaris). Cyble Coder Register:
http://itron.com/

Badger. ADE Register:
http://badgermeter.com/

Elster AMCO (ABB/Kent). InVision Register, evoQ4 Mag-Meter:
http://elsteramcowater.com/

Hersey. Translator Register:
http://www.herseymeters.com/

Master Meter. Acculinx Register.
http://mastermeter.com/

Metron Farnier. HawkeyeOER Register:
http://metronfarnier.com/

Neptune (Schlumberger). E-Coder and ProRead Registers:
http://neptunetg.com/

Sensus (Rockwell). ICE, ECR, and OMNI-T2 Registers:
http://www.sensus.com/

Siemens (Sitrans). F M MAG 8000 (CT) Mag-Meter:
http://www.siemens.com/

INDUSTRIAL COMMUNICATION PROTOCOLS:

Official MODBUS-IDA Consortium:
http://modbus.org

MODBUS Protocol Specification:
http://modbus.org/docs/PI_MBUS_300.pdf

DF1 Protocol Specification:
http://literature.rockwellautomation.com/idc/groups/literature/documents/rm/1770-rm516_-en-p.pdf

ADAM-4000 Protocol Specification:
http://taiwan.advantech.com.tw/unzipfunc/Unzip/1-2CYUNZ/ADAM-4000%20manual%20Ed%2010.5.pdf

EtherNet/IP Protocol Information:
http://odva.org , http://www.rockwellautomation.com/enabled/pdf/eipexp1_2.pdf

AUXILIARY DEVICES:

Analog Isolation and Input Modules – Dataforth Corporation
http://dataforth.com/

Solid State Relays – Power IO
http://power-io.com/

Solid State Relays - Crouzet:
http://crouzet-usa.com/catalog/_ssr.shtml

Serial Displays - Scott Edwards Electronics:
http://seetron.com/vfd420_1.htm
http://seetron.com/vfdmnl/mnl.htm

THIRD PARTY SOFTWARE:

'Simply Modbus' Data Communication Test Software
http://simplymodbus.ca

'HyperTerminal' Terminal Emulation Software:
http://hilgraeve.com

21 LIMITED WARRANTY

SCADAMETRICS
LIMITED WARRANTY

1.0 GENERAL TERMS:

1.1 This Limited Warranty is extended only to the original end-user purchaser (CUSTOMER) and is not transferable.

1.2 No agent, reseller, or business partner of SCADAmetrics is authorized to modify the terms of this Limited Warranty on behalf of SCADAmetrics.

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1.10 SCADAmetrics shall not be responsible for any hardware or other components that is interconnected with SCADAmetrics components by the CUSTOMER or third parties.

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2.3 To contact SCADAmetrics Technical Support, please call (636)938-9633 or email support@scadametrics.com. For up-to-date telephone numbers and/or email addresses, please see the SCADAmetrics corporate web site at: www.scadametrics.com

2.4 CUSTOMER should have the following information/items readily available when contacting SCADAmetrics:

1. MAC ID of the EtherMeter experiencing the problem.
2. A description of the problem.
3. Make and Model Numbers of Interconnected Meter Register(s).
4. Make and Model Numbers of Interconnected Auxiliary I/O Sensor(s).
5. Wiring Diagram of the EtherMeter experiencing the problem.
6. Screen snapshot(s) of Meter Troubleshooting Display.
7. The date and time when the problem first occurred.
8. SCADA/Telemetry history tabulations/data that provide insight into the problem.

3.0 WARRANTY REPLACEMENT:

3.1 In the event SCADAmetrics Technical Support or its authorized Service Personnel determines the product or part has a malfunction or failure attributable directly to faulty workmanship and/or materials; and the product is within the TWO (2) YEAR warranty term, then SCADAmetrics will commence a warranty repair or replacement.

3.2 The warranty covers the repair or replacement of defective component(s) within the EtherMeter. The warranty does not cover costs associated with the retrieval, inbound shipping, and re-installation of the defective component(s). For warranty repaired/replaced components, SCADAmetrics shall cover the cost of ground shipping from SCADAmetrics to the end user.

3.2 Products or parts shipped to SCADAmetrics without prior authorization will not be accepted.

3.3 CUSTOMER agrees to insure the product or assume the risk of loss or damage that may occur in transit; and to use a shipping container equivalent to the original packaging.

3.4 Responsibility for loss or damage does not transfer to SCADAmetrics until the returned product or part is received at a designated SCADAmetrics facility.

3.5 Once a component has been visually inspected and tested, SCADAmetrics will, at its sole discretion, repair or replace, using new or reconditioned product or parts, to whatever extent it deems necessary to restore the product or part to operating condition.

3.6 SCADAmetrics shall not be liable for any damages caused by delay in delivering or furnishing repaired or replaced product or part.

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4.3 THE DEVICE IS NOT INTENDED FOR USE IN THE OPERATION OF NUCLEAR FACILITIES, AIRCRAFT NAVIGATION OR COMMUNICATION SYSTEMS, AIR TRAFFIC CONTROL SYSTEMS, LIFE SUPPORT MACHINES OR OTHER EQUIPMENT IN WHICH THE FAILURE OF THE SOFTWARE COULD LEAD TO DEATH, PERSONAL INJURY, PROPERTY DAMAGE, OR SEVERE PHYSICAL OR ENVIRONMENTAL DAMAGE. TO THE FULL EXTENT ALLOWED BY LAW, THE FOREGOING WARRANTIES AND REMEDIES ARE EXCLUSIVE AND ARE IN LIEU OF ALL OTHER WARRANTIES, TERMS, OR CONDITIONS, EXPRESS OR IMPLIED, EITHER IN FACT OR BY OPERATION OF LAW, STATUTORY OR OTHERWISE, INCLUDING WARRANTIES, TERMS, OR CONDITIONS OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, SATISFACTORY QUALITY, CORRESPONDENCE WITH DESCRIPTION, AND NON-INFRINGEMENT, ALL OF WHICH ARE EXPRESSLY DISCLAIMED. SCADAMETRICS NEITHER ASSUMES NOR AUTHORISES ANY OTHER PERSON TO ASSUME FOR IT ANY OTHER LIABILITY IN CONNECTION WITH THE SALE, INSTALLATION, MAINTENANCE, WARRANTY, OR USE OF ITS PRODUCTS.

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This Limited Warranty shall be governed by the laws of the State of Missouri, U.S.A. excluding its conflicts of laws principles and excluding the United Nations Convention on Contracts for the International Sale of Goods.

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ST. LOUIS, MISSOURI 63025 USA

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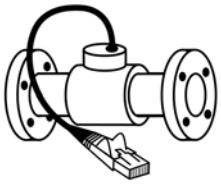
12. This License Agreement is the entire and exclusive agreement between Licensor and Licensee regarding this Firmware. This License Agreement replaces and supersedes all prior negotiations, dealings, and agreements between Licensor and Licensee regarding this Firmware.

13. This License Agreement is governed by the law of MISSOURI applicable to MISSOURI contracts.

14. This License Agreement is valid without Licensor's signature. It becomes effective upon the earlier of Licensee's signature or Licensee's use of the Firmware.



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